Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 06, Issue: 03 (MAY-JUNE, 2026)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Evaluation of Energy Expenditure and Biomechanical Load in Female Agricultural Workers

*Chethan R and Dr. Veena Jadhav
Department of Resource Management and Consumer Science, College of Community Science, UAS, Dharwad, Karnataka, India
*Corresponding Author's email: rajappakm951@gmail.com

Agriculture remains one of the most labor-intensive occupations worldwide, with women contributing significantly to farming activities such as sowing, transplanting, weeding, harvesting, and post-harvest operations. Despite their substantial involvement, female agricultural workers often perform physically demanding tasks under unfavorable ergonomic conditions. These activities result in high energy expenditure and increased biomechanical load, leading to fatigue, musculoskeletal disorders (MSDs), and reduced work efficiency. This article evaluates the energy expenditure and biomechanical stress experienced by female agricultural workers during various farming operations. It also discusses ergonomic interventions and women-friendly agricultural tools to reduce drudgery and improve occupational health.

Introduction

Women constitute a major part of the agricultural workforce and contribute significantly to food production, livestock management, and post-harvest processing, particularly in developing countries like India. In rural areas, women are actively engaged in labor-intensive agricultural activities such as sowing, transplanting, weeding, harvesting, threshing, carrying loads, and processing agricultural products. Their contribution is essential for sustaining agricultural productivity and rural livelihoods. Despite their crucial role, women agricultural workers often remain unrecognized and face challenging working conditions that negatively affect their health and well-being. Agricultural work is physically demanding in nature and frequently involves repetitive movements, prolonged standing, continuous bending, squatting, twisting, and lifting heavy loads manually. These activities place excessive stress on different parts of the body, particularly the lower back, shoulders, neck, wrists, and knees. Traditional farming methods and the use of poorly designed hand tools further increase the physical strain experienced by women workers. Most agricultural implements are designed considering male anthropometric dimensions, making them unsuitable and uncomfortable for women to use efficiently.

Energy expenditure is an important physiological parameter used to assess the amount of energy utilized by the body during physical work. Agricultural activities often require moderate to heavy physical effort, leading to increased heart rate, oxygen consumption, and muscular fatigue. Female workers performing manual farm operations may experience high levels of energy expenditure due to continuous physical labor under extreme environmental conditions such as heat, humidity, and uneven terrain. Excessive energy demands can result in fatigue, reduced productivity, and long-term health complications. Biomechanical load refers to the mechanical stress imposed on muscles, joints, ligaments, tendons, and bones while performing work-related tasks. In agriculture, awkward working postures, repetitive motions, and manual material handling significantly contribute to biomechanical stress. Continuous exposure to such stress can lead to musculoskeletal disorders (MSDs), including

lower back pain, joint stiffness, muscle strain, and chronic fatigue. These disorders not only affect the physical health of women workers but also reduce their work efficiency and quality of life.

Several studies have reported that women involved in agricultural operations are highly vulnerable to occupational health problems because of inadequate mechanization, lack of ergonomic awareness, and absence of women-friendly farm tools. Moreover, socio-economic constraints and limited access to healthcare further worsen their condition. Therefore, evaluating energy expenditure and biomechanical load among female agricultural workers is essential for understanding the physiological and ergonomic challenges associated with farm work. Assessment of physiological workload and biomechanical stress helps identify high-risk activities and provides a scientific basis for designing ergonomic interventions. Techniques such as heart rate monitoring, posture analysis, ergonomic assessment methods, and biomechanical evaluation are commonly used to measure physical workload and occupational risk factors. These evaluations assist researchers and policymakers in developing improved agricultural tools, better work practices, and safer working environments for women.

The adoption of ergonomic principles in agriculture can significantly reduce drudgery, improve comfort, enhance productivity, and minimize the occurrence of work-related injuries among female agricultural workers. Therefore, there is an urgent need to focus on gender-sensitive agricultural technologies and occupational health strategies to improve the overall well-being and efficiency of women engaged in farming activities.

Energy Expenditure in Agricultural Activities

Agricultural tasks require varying levels of physical effort depending on the type of activity, duration, environmental conditions, and tools used. Female agricultural workers often experience high cardiovascular stress due to continuous manual labor.

Common High-Energy Agricultural Activities

- Manual transplanting
- Weeding using traditional hand tools
- Harvesting crops manually
- Carrying heavy loads such as water, fodder, and harvested produce
- Threshing and winnowing operations

The energy expenditure during these activities is usually measured through:

- Heart rate monitoring
- Oxygen consumption analysis
- Caloric expenditure estimation
- Physiological workload assessment

Studies indicate that manual weeding and transplanting are among the most energy-consuming tasks for women workers due to continuous bending and repetitive movements.

Biomechanical Load Among Female Agricultural Workers

Biomechanical stress occurs when workers perform repetitive motions, maintain static postures, or lift heavy objects repeatedly. Women agricultural workers commonly suffer from discomfort in:

- Lower back
- Neck
- Shoulders
- Knees
- Wrists

Factors Contributing to Biomechanical Load

1. Poor posture during work
2. Long working hours
3. Inadequate rest periods

4. Use of non-ergonomic traditional tools
5. Carrying excessive loads manually
6. Uneven field conditions

Common Disorders Observed

- Lower back pain
- Joint stiffness
- Muscle fatigue
- Tendinitis
- Musculoskeletal disorders (MSDs)

These health problems reduce work efficiency and negatively affect the quality of life of female workers.

Methods Used for Evaluation

Researchers use several techniques to assess biomechanical load and energy expenditure:

Physiological Measurements

- Heart rate measurement
- Blood pressure monitoring
- Oxygen uptake analysis

Ergonomic Assessment Tools

- Rapid Entire Body Assessment (REBA)
- Rapid Upper Limb Assessment (RULA)
- Ovako Working Posture Analysis System (OWAS)

Biomechanical Analysis

- Posture analysis
- Motion capture techniques
- Joint angle measurement
- Force and load analysis

These methods help identify high-risk activities and recommend ergonomic improvements.

Ergonomic Interventions

To reduce physical strain and improve efficiency, ergonomic interventions are essential.

Recommended Interventions

- Introduction of women-friendly agricultural tools
- Improved handle design for farm implements
- Use of lightweight equipment
- Mechanization of repetitive tasks
- Training on proper body posture
- Scheduled rest breaks

Benefits of Ergonomic Improvements

- Reduced fatigue
- Lower risk of musculoskeletal disorders
- Increased productivity
- Improved comfort and safety
- Enhanced work efficiency

Discussion

The evaluation of energy expenditure and biomechanical load highlights the severe occupational stress experienced by female agricultural workers. Traditional farming techniques significantly contribute to physical exhaustion and health complications. Ergonomically designed interventions can effectively reduce drudgery and improve occupational well-being. Governments, agricultural institutions, and researchers should prioritize the development of gender-sensitive technologies and awareness programs for rural women workers.

Conclusion

Female agricultural workers are exposed to considerable biomechanical stress and high energy expenditure during farming operations. Repetitive manual work, awkward postures, and unsuitable tools contribute to fatigue and musculoskeletal disorders. Proper ergonomic assessment and intervention strategies are necessary to improve occupational health, safety, and productivity. The adoption of women-friendly agricultural technologies can significantly enhance the quality of life and working conditions of female farm workers.