

Working in the Cold: Musculoskeletal Experiences and Biocultural Adaptation among Potato Farmers in the Dieng Plateau, Wonosobo

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Abstract. Cold environments and physical work are closely related to the bodily experiences of potato farmers in the Dieng Plateau. Farmers engage in various physical activities, such as bending, squatting, lifting, carrying, and walking while being exposed to low temperatures. These conditions may shape musculoskeletal experiences, including soreness, pain, stiffness, and fatigue, which are felt during or after work. This study aims to explain the musculoskeletal experiences of potato farmers working in cold environments, how farmers understand the relationship between cold temperatures and bodily discomfort, and the biocultural practices they use to adapt. This study employed a qualitative research method with a focused ethnography approach. Data were collected through semi-structured interviews, participant observation, and field notes involving potato farmers in the Dieng Plateau, Wonosobo. The data were analyzed using reflexive thematic analysis through a process of coding and theme development. The findings show that (1) farmers' musculoskeletal experiences are shaped by the interaction between physical workload and exposure to cold environments; (2) farmers interpret soreness, pain, stiffness, and fatigue based on their work experiences and local knowledge; and (3) biocultural adaptation is practiced through adjustments in clothing, body movements, working hours, rest patterns, and knowledge of environmental conditions. Therefore, the musculoskeletal experiences of potato farmers should be understood as embodied experiences that connect biological, occupational, environmental, and cultural aspects.

Keywords: potato farmers, cold environment, musculoskeletal, embodiment, biocultural adaptation.

1. INTRODUCTION

Humans are constantly connected to their environment in their everyday lives. This relationship exposes the human body to various environmental conditions, such as air temperature, humidity, and wind. Low temperatures can place stress on the body because it must maintain a stable internal temperature. The body responds to this stress through physiological mechanisms that help maintain body temperature (Mäkinen & Hassi, 2009). The body's responses to cold may also change after repeated exposure to low temperatures. This process is known as habituation or adaptation to cold exposure (Castellani & Young, 2016). Bodily adaptation is not limited to physiological processes, as humans also use various strategies to cope with cold environments. Anthropological studies show that human capacity to live in extreme environments develops through the interaction between biology and culture (Ocobock et al., 2021). Through this interaction, people use clothing, shelter, habits, and activity patterns as part of their strategies for coping with the environment. The regulation of activities becomes particularly important when people must perform physical work in cold environments. Physical work requires the body to remain active and continuously use its muscles throughout the activity. Therefore, cold conditions become increasingly important when the environment also serves as a space for human labor.

A cold workplace requires the body to respond to environmental conditions and work demands simultaneously. Physical work requires appropriate bodily movements, meaning that changes in bodily performance caused by low temperatures may affect work activities. Cold exposure can reduce hand movement and manual performance (Ray et al., 2019). Reduced manual performance becomes particularly important when work

requires repetitive movements or continuous physical effort. Cold environments are also associated with musculoskeletal experiences among certain groups of workers. Studies on cold exposure have found associations between low temperatures and several musculoskeletal complaints, although research findings remain mixed (Höper et al., 2022). These differences suggest that cold cannot be considered the sole cause of bodily complaints. Work type, exposure duration, body posture, and physical workload may also shape a person's musculoskeletal experiences. Work-related factors are particularly important for farmers because agricultural activities often require considerable physical effort. Farmers may perform heavy lifting, carry agricultural products, bend repeatedly, and engage in repetitive movements. Working conditions involving heavy lifting and repetitive movements are indeed associated with musculoskeletal problems among agricultural workers (Shivakumar et al., 2024). Thus, the interaction between environmental conditions and physical workload makes farmers' bodies a site where cold exposure and work demand meet.

The interaction between environmental exposure and work demands can be clearly observed in the lives of potato farmers in the Dieng Plateau. Dieng is a highland area with a cool climate and a long history of agricultural activity. Environmental studies indicate that Dieng is located at approximately 2,000-2,500 meters above sea level and has a cool and often foggy climate (Kealy et al., 2012). These environmental conditions coexist with the development of potato farming, which has become an important economic activity in the Dieng area. van Noordwijk et al. (2014) describe the Dieng Plateau as one of Indonesia's potato production centers, supplying the needs of urban markets. Potato farming requires farmers to perform various physical activities regularly throughout the production process. These activities involve the use of bodily strength and direct interaction with agricultural land. Research on occupational risks among farmers also shows that individual, occupational, environmental, and psychosocial factors need to be considered together when assessing musculoskeletal problems (Gholami et al., 2025). This perspective is important because farmers' bodily experiences do not emerge from a single factor. Bodily experiences may also be shaped by how farmers understand pain, assess environmental conditions, and organize their work activities. This understanding opens space for research that does not view the body solely through medical or ergonomic risks. It is also necessary to examine how farmers experience their bodies and use everyday practices when working in cold conditions. Therefore, further research is needed to explore how potato farmers in the Dieng Plateau, Wonosobo experience and interpret musculoskeletal discomfort while working in cold environments, as well as how they develop biocultural adaptation practices in their everyday working lives.

Based on this background, the research questions are formulated as follows:

- 1) How do potato farmers experience musculoskeletal discomfort while working in the cold environment of the Dieng Plateau?
- 2) How do potato farmers interpret the relationship between cold exposure, agricultural work, and their musculoskeletal experiences?
- 3) How do potato farmers use biocultural practices to adapt to and manage musculoskeletal discomfort in their everyday working lives?

2. LITERATURE REVIEW

Biocultural Adaptation

Biocultural adaptation is a concept that views human adaptation through the relationship between the body, culture, and the environment. Dufour (2006) states that the biocultural approach connects biological, social, cultural, and environmental data. This relationship shows that humans do not respond to their environment only through biological changes. Humans also use habits and practices that develop through everyday life. Goodman and Leatherman (1998) show that social and cultural conditions can influence human biology through everyday life. Such influences can be observed through work activities, lifestyles, health, and environmental conditions. Stinson et al. (2000) also position human adaptation as the result of interactions among biological, cultural, and environmental factors. This relationship makes the environment an important part of human life. This perspective is relevant to the lives of potato farmers in the Dieng Plateau, who regularly work in low-temperature environments. Farmers may adapt through work clothing, working schedules, rest patterns, food, and other practices that develop from their experiences. These practices show that responses to the environment occur not only through the body but also through cultural practices. Therefore, the concept of biocultural adaptation is used to understand how potato farmers adjust their bodies and everyday practices to the cold environment of the Dieng Plateau.

Embodiment

Embodiment is a concept that views the body as the basis of human experience in relation to the environment and social life. Csordas (1990) argues that the body is not merely an object of culture but also the basis through which people experience culture. This understanding positions the body as an active part of human experience. Bodily experiences may emerge through sensations of cold, pain, fatigue, stiffness, and comfort when people engage in everyday activities. Csordas (1993) explains that attention to bodily sensations is also related to a person's relationship with the surrounding world. Bodily sensations can then help people understand the conditions they are experiencing. Scheper-Hughes and Lock (1987) also show that the body can be understood as both a personal experience and a part of social and cultural life. This understanding means that pain does not necessarily have the same meaning for everyone. Potato farmers may experience soreness or stiffness while working and then relate these experiences to cold temperatures, work activities, age, or fatigue. The meanings attached to pain may then influence how farmers respond to their bodily conditions. These experiences indicate that musculoskeletal complaints need to be understood through farmers' bodily experiences and social lives. Therefore, the concept of embodiment is used to understand the musculoskeletal experiences of potato farmers as bodily experiences that are felt and interpreted through everyday work activities.

Occupational Health

Occupational health is a concept that refers to efforts to maintain people's health and ability to work by considering working conditions and the work environment. The International Labour Organization (2013) states that occupational health aims to promote and maintain the physical, mental, and social well-being of workers. This objective shows that workers' health is not limited to diseases that develop after work. Working conditions also need to be considered because work activities can affect bodily health. The World Health Organization (2022) states that occupational health includes efforts to promote workers' health and work capacity, as well as safe and healthy working conditions. The work environment is therefore an important part of understanding workers' health. Osborne et al. (2012) show that farmers face risks of musculoskeletal disorders associated

with work activities and occupational demands. These risks may arise from physical workload, body posture, repetitive movements, and long working hours. Such conditions are relevant to potato farming activities, which often involve bending, squatting, lifting, carrying, and walking on agricultural land. Cold environments are also part of the working conditions experienced by farmers while performing these activities. The relationship between occupational demands and environmental conditions means that farmers' musculoskeletal experiences need to be understood as part of occupational health. Therefore, the concept of occupational health is used to understand the relationship between agricultural activities, environmental conditions, and the musculoskeletal experiences of potato farmers in the Dieng Plateau.

3. METHODOLOGY

Qualitative research is an approach used to understand human experiences through stories, actions, and everyday life. This study employed focused ethnography because it has a specific focus on the musculoskeletal experiences of potato farmers working in a cold environment. Knoblauch (2005) states that focused ethnography is characterized by relatively short field visits combined with intensive data collection. This approach is suitable for a study that focuses on the bodily experiences and work activities of potato farmers. The research was conducted in the Dieng Plateau, covering the Kejajar District, Wonosobo Regency, Central Java. This area was selected because Dieng is one of the regions with intensive potato farming and experiences low temperatures and frost, locally known as *embun upas* (Pradana et al., 2019). These conditions indicate that cold environments are a real part of agricultural life in Dieng. Aini and Faqih (2021) also show that frost in Dieng generally occurs during the dry season and can affect farmers' lives. Research participants were selected purposively based on the criteria that they were actively engaged in potato farming and had regular experience working on agricultural land in Dieng. Data were collected through semi-structured interviews, participant observation, and field notes. Interviews were conducted to explore farmers' experiences of cold, soreness, pain, stiffness, and fatigue, as well as their understanding of the relationship between bodily conditions and agricultural work. Participant observation was used to examine work clothing, body postures, repetitive movements, bending, squatting, lifting, carrying agricultural products, field conditions, and rest periods. Field notes were used to record environmental conditions and activities observed during the research process. Interview and observation data were analyzed using reflexive thematic analysis through a process of reading the data thoroughly, generating codes, developing themes, reviewing themes, and interpreting the meaning of the data (Braun & Clarke, 2021). The analysis focused on three main themes: farmers' musculoskeletal experiences in cold environments, farmers' interpretations of cold conditions and agricultural work, and biocultural practices for adapting to and managing musculoskeletal discomfort. The researcher also obtained informed consent from participants before data collection and protected their identities throughout the research process. Therefore, the entire research process was conducted in an integrated manner to develop a comprehensive understanding of the relationship between cold environments, agricultural work, bodily experiences, and adaptation practices among potato farmers in the Dieng Plateau.

4. RESULT AND DISCUSSIONS

Musculoskeletal Experiences of Potato Farmers in a Cold Environment

The musculoskeletal experiences of potato farmers in the Dieng Plateau show a close relationship between cold temperatures and physical work activities. Potato farmers perform various tasks that require continuous physical effort. These activities include preparing the soil, planting, caring for crops, lifting harvested potatoes, and carrying work equipment. Such tasks also often require farmers to bend, squat, stand for long periods, and lift loads. Helliwell et al. (2023) explain that agricultural workers face a risk of musculoskeletal disorders due to the high physical demands of their work. Akbar et al. (2023) also show that non-ergonomic working positions, repetitive movements, length of employment, and heavy lifting are factors frequently associated with musculoskeletal complaints among farmers in Southeast Asia. These risks become more complex when physical activities take place in low-temperature environments. Farbu et al. (2021) found that working in cold environments is associated with an increased risk of musculoskeletal complaints over time. These findings indicate that farmers' bodily experiences are related not only to the type of work they perform but also to the conditions of their working environment. Therefore, the musculoskeletal experiences of potato farmers in Dieng need to be understood as the result of the interaction between physical workload and exposure to cold temperatures.

Table 1. Relationship between Work Activities, Cold Exposure, and Musculoskeletal Experiences among Potato Farmers

Potato Farming Activity	Physical Demands	Environmental Conditions	Potential Musculoskeletal Experiences	Related Concept
Soil preparation and cultivation	Bending, squatting, and swinging tools	Cold air and wet soil	Lower back, knee, and shoulder pain	Occupational health
Planting and crop maintenance	Squatting, bending, and repetitive movements	Prolonged exposure to cold	Soreness in the lower back, legs, and hands	Embodiment
Lifting harvested potatoes	Lifting, carrying, and walking	Physical load combined with cold temperatures	Back, shoulder, and arm pain	Occupational health
Carrying work equipment	Walking and carrying loads	Sloping terrain and cold air	Bodily fatigue and leg pain	Biocultural adaptation
Repeating work activities every day	Repetitive movements and physical labor	Repeated environmental exposure	Recurring musculoskeletal complaints	Biocultural adaptation

Source: Compiled by the authors based on field data, Akbar et al. (2023), Burström et al. (2022), Csordas (1990), Goodman and Leatherman (1998), and Walker-Bone et al. (2023).

These activity patterns indicate that farmers' bodies experience several forms of physical stress simultaneously. The first comes from physical movements that are

repeatedly performed throughout the agricultural process. The second comes from body positions that frequently change according to the demands of the work. The third comes from environmental temperatures, which may intensify bodily discomfort while the body is engaged in physical labor. Davis and Kotowski (2007) explain that farmers commonly experience problems in the lower back, shoulders, and upper limbs due to the nature of agricultural work. Osborne et al. (2012) also categorize farmers' risk factors into work-related characteristics, individual characteristics, and psychosocial factors. This classification helps explain that bodily complaints do not arise from a single cause. Cold conditions then become an environmental factor that contributes to these work experiences. Lewis et al. (2023) found an association between occupational cold exposure and pain in the neck, shoulders, and lower back. This relationship indicates that the work environment can influence bodily experiences while farmers perform physical activities. Therefore, the table above illustrates that the musculoskeletal experiences of potato farmers cannot be understood solely through their work movements but must also be examined through the relationship between the body, work, and environment.

The relationship between the body, work, and environment can also be understood through the concept of embodiment. Embodiment views the body as a part of human experience that directly senses and experiences social life. Scheper-Hughes and Lock (1987) conceptualize the body through individual experience, social relationships, and forms of power that shape human life. This perspective helps us understand soreness and pain not simply as isolated physical symptoms. Pain can be an experience that emerges as the body performs work activities continuously. Such experiences are then influenced by the social and cultural environment in which farmers live and work. McElroy (1990) explains that biocultural research connects biological, environmental, and cultural factors in understanding human health. Ocobock et al. (2021) also show that humans can cope with cold environments through the interaction between bodily capacities and cultural strategies. This relationship is important for potato farmers in Dieng because agricultural work takes place as part of the everyday life of the local community. Therefore, the musculoskeletal experiences of potato farmers can be understood as embodied experiences shaped by the relationship between work activities, cold exposure, and the way of life of the Dieng community.

Farmers' Interpretations of Cold, Work, and Musculoskeletal Discomfort

The bodily experiences that emerge from physical work shape how farmers understand cold and bodily discomfort. Farmers do not always view soreness as a sign of illness that requires them to stop working immediately. Soreness may instead be understood as a normal part of the work they perform every day. This understanding shows that health experiences are not shaped solely by the biological condition of the body. Nichter (2008) explains that people give cultural meanings to various bodily sensations they experience. These meanings are then influenced by work experiences and local understandings of health. Throop (2012) also shows that experiences of pain are related to bodily experiences that are both sensory and emotional. This perspective helps demonstrate that cold and soreness experienced by farmers are not merely physical sensations. Farmers also evaluate these sensations based on their experiences of working and interacting with their surroundings. Honkasalo (1998) shows that experiences of pain can shape how people experience space through their bodies. Therefore, the ways in which potato farmers in Dieng understand cold and bodily discomfort need to be viewed as embodied experiences that carry social and cultural meanings.

The meanings attached to cold are also related to how farmers assess their bodily capacity while working. Farmers who have worked for a long time in mountainous areas may recognize changes in their bodily conditions through everyday experience. Such knowledge may emerge through simple signs, such as stiff hands, a sore lower back, heavy shoulders, or increased fatigue. These experiences allow farmers to develop their own ways of distinguishing between discomfort that can still be endured and pain that is considered disruptive to their work. Doran (2014) shows that experiences of pain can change as individuals develop relationships with the pain they experience. Bullington (2009) also explains that pain can transform a person's relationship with the body and the world in which they live. This understanding indicates that farmers do not passively experience discomfort. They also evaluate bodily sensations according to work demands and previous experiences. Costanzo and Verghese (2018) explain that the concept of embodiment helps us understand how pain shapes a person's lived experience. Therefore, farmers' interpretations of cold and bodily discomfort can be understood as a process in which bodily experiences intersect with the demands of everyday work.

Table 2. Farmers' Interpretations of Cold, Work, and Musculoskeletal Discomfort

Farmers' Bodily Experiences	Possible Interpretations	Responses to Bodily Conditions	Anthropological Meaning
The body feels cold when starting work	Cold is considered a normal condition in the Dieng environment	Continuing to work while adjusting clothing or movements	Cold becomes part of everyday life
The lower back feels sore after bending	Soreness is considered a consequence of work	Changing body position or taking a short rest	The body registers workload through sensation
The hands feel stiff when the air is very cold	Cold is considered to affect movement and comfort	Moving the hands or finding ways to warm the body	Sensations become a source of local knowledge
The shoulders feel heavy after carrying harvested potatoes	The load is considered part of the work	Reducing the load or asking for assistance	The body indicates the limits of work capacity
Pain repeatedly occurs after work	Pain may be considered a consequence of work	Adjusting activities or continuing to work	Pain is understood through social and work experiences

Source: Compiled by the authors based on field data, Csordas (1990), Burström et al. (2022), Goodman and Leatherman (1998), and Walker-Bone et al. (2023).

The table shows that a single bodily sensation may have different meanings depending on farmers' experiences. Cold is not always understood as a health threat that must be avoided. It may also be considered a normal part of agricultural life in a highland environment. This understanding can influence farmers' decisions when their bodies

begin to experience discomfort. Nichter (2008) explains that people's understandings of bodily sensations are influenced by local knowledge about health and illness. Throop (2012) shows that experiences of pain also have a sensory dimension that cannot be separated from a person's lived experience. Johansen (2002) demonstrates that experiences of pain may acquire different meanings when individuals understand their bodies through social and cultural frameworks. These findings strengthen the argument that farmers' soreness cannot be understood solely through medical measures. Soreness also needs to be examined through how farmers explain its causes and decide what to do after experiencing it. This knowledge then becomes part of how farmers maintain their bodily capacity to continue working. Therefore, the table demonstrates that interpretations of cold and bodily discomfort are an important part of the health experiences of potato farmers in Dieng.

These interpretations also demonstrate a relationship between bodily experiences and farmers' ability to maintain their work activities. Farmers may continue working when they perceive that their discomfort remains within an acceptable limit. This decision does not mean that farmers do not experience pain. Rather, it shows that pain occupies a particular position within economic demands and work responsibilities. Doran (2014) shows that people may develop particular ways of dealing with pain, which can change their relationship with the experience. Bullington (2009) explains that pain can increase bodily awareness because a body that was previously taken for granted becomes strongly noticeable. This experience may help explain why farmers can more easily recognize parts of their bodies that become sore after performing particular tasks. Lewis et al. (2023) also show an association between cold exposure and several musculoskeletal complaints. This relationship indicates that cold is not merely a background condition of the workplace but can become part of the bodily experience while work is taking place. Therefore, farmers' ways of understanding cold and bodily discomfort reveal a relationship between the need to work, bodily capacity, and environmental conditions.

The relationship between the need to work and bodily capacity further shows that pain has a broader meaning than simply being a physical disturbance. Farmers may view their bodies as an important part of their ability to sustain their work and family life. A strong body enables farmers to complete their work, while a tired or painful body may reduce this ability. Honkasalo (1998) explains that a body experiencing pain may change the way a person moves and experiences space. This experience shows that pain can alter a person's relationship with the working environment. Costanzo and Verghese (2018) also explain that embodiment allows illness and pain to be understood as part of a person's lived experience. Nichter (2008) adds that meanings attached to bodily sensations can develop through values and knowledge within a community. This perspective shows that potato farmers do not experience cold only as a biological condition but also give meaning to cold through their work experiences. These meanings then influence how farmers assess soreness and determine their responses to bodily conditions. Therefore, farmers' interpretations of cold, work, and musculoskeletal discomfort are an important part of understanding their health experiences from a biocultural perspective.

Biocultural Adaptation of Potato Farmers to the Cold Environment of Dieng

Potato farmers in Dieng demonstrate biocultural adaptation through the relationship between the human body, work practices, and cold environmental conditions. The Dieng environment has low temperatures because of its highland location, requiring farmers to face cold air while working in agricultural fields. Under these conditions, the body uses

physiological responses such as vasoconstriction and shivering to maintain body heat (Castellani & Young, 2016). These bodily responses occur alongside human practices that help reduce exposure to cold air. Wearing thick clothing, keeping the body active, and choosing specific working times can serve as forms of behavioral thermoregulation (Cramer & Jay, 2016). These patterns show that human adaptation does not occur only through bodily changes but also through learned practices that are repeatedly performed. Beall (2023) explains that research on human adaptation to climate needs to consider temperature, humidity, radiation, and altitude as environmental stressors. These stressors become particularly important for farmers because their work takes place directly in open environments. Therefore, the lives of potato farmers in Dieng can be understood as a process of adaptation that connects biological responses with everyday work practices.

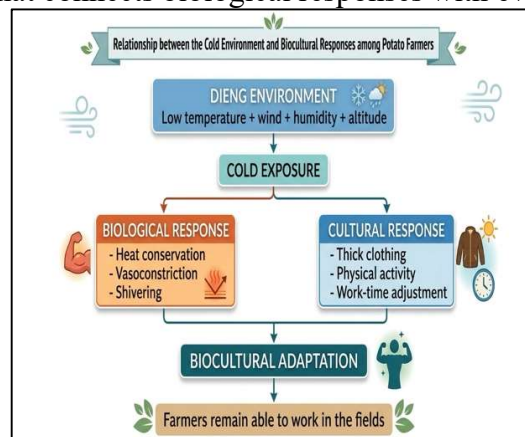


Figure 1. Relationship between the Cold Environment and Biocultural Responses among Potato Farmers

Source: Personal document.

Biocultural adaptation becomes even more apparent when farmers regulate their clothing and physical activity while working. Clothing serves as a protective layer that reduces heat loss when the air becomes very cold. Gilligan (2008) shows that clothing can be understood as a form of behavioral adaptation to cold exposure because it helps the body maintain thermal conditions. This practice does not occur in isolation, as farmers also regulate their body movements while working to keep the body producing heat. Physical activity can generate heat through muscle activity, meaning that the body does not rely solely on clothing for protection. Castellani and Young (2016) explain that physical activity and protective behaviors are important components of how humans cope with cold environments. These practices can also develop through experience as farmers learn to recognize air conditions that feel colder or more comfortable. Such experiences then form practical knowledge that helps farmers adjust their work practices to environmental conditions. Ocobock et al. (2021) emphasize that adaptation to cold should consider the relationship between biological and behavioral factors because both can operate together. Therefore, clothing, body movements, and work experience can be understood as parts of the biocultural adaptation system of potato farmers in Dieng.

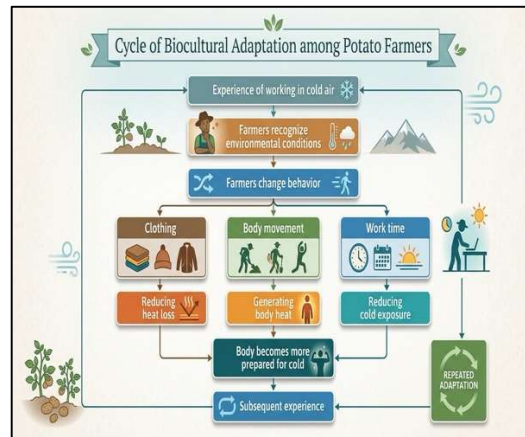


Figure 2. Cycle of Biocultural Adaptation among Potato Farmers
Source: Personal document.

Farmers' work experiences also shape adaptation patterns that involve not only the body but also work-related decisions. Farmers may choose times when environmental conditions are considered more suitable for their bodily capacity and crop requirements. Such choices are important because frost, locally known as *embun upas*, can occur when temperatures fall to freezing levels and may damage potato crops. Pradana et al. (2019) found that potato-growing areas in Dieng have a high level of vulnerability to frost, requiring farmers to develop preparedness strategies. These strategies may include site selection, planting-calendar adjustments, land modification, and early warning systems. Such choices demonstrate that environmental knowledge is an important part of farmers' cultural adaptation. This knowledge is then connected to biological conditions because work-related decisions also determine how long the body is exposed to cold air. Daanen and van Marken Lichtenbelt (2016) explain that repeated cold exposure can be associated with processes of habituation to low temperatures, although the forms of adaptation may differ among individuals and populations. Gordon et al. (2019) also found that repeated cold exposure may reduce the intensity of shivering and increase non-shivering thermogenesis. Therefore, farmers' experiences of dealing with cold can be understood as a process that brings together local knowledge, work behavior, and physiological responses.

Table 3. Forms of Biocultural Adaptation among Potato Farmers to the Cold Environment of Dieng

Environmental Stressor	Biological Response	Behavioral or Cultural Response	Adaptive Function
Low air temperature	Vasoconstriction and increased heat production	Wearing thick clothing	Reducing heat loss
Cold air during work	Shivering and increased metabolism	Keeping the body active	Maintaining body heat
Repeated cold exposure	Habituation and acclimatization processes	Developing work routines	Improving the ability to cope with cold

Frost (<i>embun upas</i>)	Bodily exposure to environmental thermal stress	Adjusting work schedules and planting calendars	Reducing exposure and agricultural risk
Cold conditions and weather changes	Thermoregulatory responses	Using environmental knowledge	Supporting work-related decision-making

Source: Compiled based on field data, Castellani and Young (2016), Daanen and van Marken Lichtenbelt (2016), Gordon et al. (2019), and Pradana et al. (2019).

The relationship between the body and culture shows that the adaptation of potato farmers in Dieng cannot be explained solely through human physiological capacity. The body has mechanisms for maintaining core temperature, but people also use knowledge and simple technologies to reduce environmental stress. Cramer and Jay (2016) explain that humans rely heavily on behavioral regulation when coping with cold environments, including physical activity, clothing, and shelter. These behavioral practices can then become habits transmitted through family experience and the working environment. Such knowledge enables farmers to act not only according to bodily conditions but also according to their understanding of environmental changes. Frisancho (1993) explains that human adaptation to environmental stress involves the relationship between physiological responses and the ways people adjust their lives to their surroundings. This relationship shows that the body and culture do not operate as two separate components. The body provides biological capacities, while culture provides practical ways to use these capacities effectively. This perspective is consistent with the biocultural approach, which views humans as both biological and social beings who continuously interact with their environments (Stinson et al., 2012). Therefore, the adaptation of potato farmers in Dieng to cold environments can be understood as a process that integrates the body, experience, local knowledge, technology, and everyday work practices.

5. CONCLUSION

- 1) The musculoskeletal experiences of potato farmers in the Dieng Plateau are shaped by the interaction between physical work activities and exposure to cold environments. Farmers perform various tasks, including preparing the soil, planting, caring for crops, lifting harvested potatoes, and carrying work equipment. These activities require the body to bend, squat, lift, carry, walk, and perform repetitive movements. Such conditions may result in soreness, pain, stiffness, and fatigue in several parts of the body, including the lower back, shoulders, back, hands, legs, and knees. Exposure to cold air is also part of these experiences because the body must maintain thermal balance while continuing to perform physical work. Therefore, farmers' musculoskeletal experiences are related not only to their physical workload but also to the environmental conditions in which their work takes place. This relationship shows that farmers' bodies become a site where occupational demands and environmental stress intersect. Thus, the musculoskeletal experiences of potato farmers in the Dieng Plateau can be understood as embodied experiences shaped by the interaction between agricultural activities, cold exposure, and everyday living conditions.
- 2) Farmers' interpretations of cold and musculoskeletal discomfort are shaped by bodily experiences that develop through ongoing agricultural activities. Farmers do not

always view soreness, stiffness, or fatigue as problems that require them to stop working. Bodily discomfort may be understood as a normal part of the work they experience every day. This understanding leads farmers to assess their bodily conditions based on the intensity of pain, work demands, previous experiences, and environmental conditions. Bodily sensations then become a source of knowledge that helps farmers recognize the limits of their physical capacity while working. This knowledge also influences their decisions about whether to change their body position, take a rest, reduce a load, ask for assistance, or continue working. This relationship shows that pain has not only a biological meaning but also social and cultural meanings because farmers interpret it based on their lived experiences. Therefore, farmers' interpretations of cold and musculoskeletal discomfort demonstrate that their health experiences cannot be understood solely through medical measures but also need to be understood through bodily experiences and everyday working life.

- 3) The biocultural practices of potato farmers in the Dieng Plateau develop through the relationship between bodily capacity, work practices, environmental knowledge, and the social conditions of farmers' lives. Farmers cope with low temperatures through various forms of adjustment, such as wearing appropriate clothing, keeping their bodies active, regulating work schedules, taking rest periods, and adjusting their movements. These practices help farmers reduce bodily discomfort while working in cold environments. Repeated experiences of dealing with cold also enable farmers to recognize changes in weather and environmental conditions that may affect agricultural activities. This knowledge helps farmers determine working times, organize agricultural activities, and manage their bodily conditions while working. Biological responses also operate together with behavioral responses, meaning that adaptation occurs not only through physiological changes but also through practices learned from experience. This relationship shows that farmers' ability to cope with cold environments develops through the interaction between the human body, the environment, and work culture. Therefore, the adaptation of potato farmers in the Dieng Plateau can be understood as a biocultural process that integrates bodily responses, local knowledge, work practices, and everyday life strategies. These practices demonstrate the farmers' ability to maintain their work activities while managing musculoskeletal discomfort in the cold highland environment.

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