Universal Journal of Agricultural Research 12(2): 356-368, 2024 http://www.hrpub.org
DOI: 10.13189/ujar.2024.120215

Traditional Sibuyas (Onion) Farming in the Philippines: An Ethnographic and Biomechanical Perspective

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Received September 22, 2023; Revised December 11, 2023; Accepted April 22, 2024

Cite This Paper in the Following Citation Styles

(a): *[1] Michael Santos, Jennifer de Jesus, Adonis Voltaire Villanueva, Melane Fernandez, Christine Saturno, Marimar Fuentes, Rayvin Pestano, Jumel Miller, Jonar Martin , "Traditional Sibuyas (Onion) Farming in the Philippines: An Ethnographic and Biomechanical Perspective," Universal Journal of Agricultural Research, Vol. 12, No. 2, pp. 356 - 368, 2024. DOI: 10.13189/ujar.2024.120215.*

(b): *Michael Santos, Jennifer de Jesus, Adonis Voltaire Villanueva, Melane Fernandez, Christine Saturno, Marimar Fuentes, Rayvin Pestano, Jumel Miller, Jonar Martin (2024). Traditional Sibuyas (Onion) Farming in the Philippines: An Ethnographic and Biomechanical Perspective. Universal Journal of Agricultural Research, 12(2), 356 - 368. DOI: 10.13189/ujar.2024.120215.*

Abstract The existing research on onion farming in the Philippines has primarily focused on its cultural and economic significance and the documentation of folk dances associated with farming culture and practices. However, there needs to be more research to understand the intricate connection between onion farming and the cultural practices and beliefs and the social dynamics that shape this agricultural practice. Furthermore, a greater understanding of the specific physical demands and movement patterns involved in onion farming is needed to provide an accurate and culturally relevant movement analysis. The study explored the cultural practices of onion farming through natural observation and immersion. Simultaneously, a biomechanical analysis uncovered the physical movements inherent in onion farming, ensuring the resulting movement analysis accurately reflects the authentic farming experience. It utilized an ethnographic approach and biomechanical analysis with 20 onion farmers who were purposively chosen. In the ethnographic phase, naturalistic observations using an observation form revealed the interaction among cultural practices, traditional agriculture, and social dynamics. Spiritual rites and traditional farming techniques, such as hand-planting and carabao plowing, bond the community to the land, preserving agriculture and culture. "Bayanihan" and group activities encourage farmers' cooperation and emotional support. Using the Mackenzie Movement Analysis Method, the biomechanical analysis identified essential movements during three crucial farming phases: Land Preparation (Panangisagana), Planting (Panangimula), and Harvesting (Panaggaapit). Shoulder, elbow, wrist, hip, knee, and ankle flexion and extension were prominent joint movements in the sagittal plane, with the main muscles of the shoulder, arm, forearm, and legs performing agonistic and antagonistic actions. This multidisciplinary study revealed the complex relationship between cultural history, sustainable agriculture, community dynamics, and biomechanics in Philippine onion cultivation. The findings of the study may provide the basis for a culturally significant folk dance on onion cultivation based on the observed movements.

Keywords Onion, Farming Practices, Traditional Farming, Biomechanical, Movement Analysis

1. Introduction

Onions hold great cultural and historical significance, renowned for their flavor, nutrition, and traditional medicinal uses [1]. Onions also have a significant historical and cultural impact. The cultivation of onions is intimately connected to the development of human

civilization and dates back thousands of years. It is essential to maintain different types of onions in order to protect the rich cultural history of a variety of groups as well as cultural diversity. According to Sagar et al. [2], onion farming is a significant agricultural activity in the Philippines, and smallholder farmers have a preponderant role in the industry. According to Sanglestsawai et al. [3], the cultivation of onions in the country is profoundly ingrained in the traditional customs and rites of the people.

Farming practices are essential in the lives and cultures of Filipino onion growers and the Philippines [4, 5]. Smallholder farmers cultivating onions protect their livelihoods and preserve centuries-old agricultural traditions linked to the country's cultural legacy [6]. The labor-intensive aspect of onion growing instills a sense of discipline, resilience, and intergenerational knowledge transfer in farming communities. These traditions build a strong connection to the land and reinforce values such as hard work, sustainability, and communal cooperation [7]. Furthermore, "onion farming is critical to the Philippines' economic development" [8]. As one of the world's leading onion growers, the country depends on the performance of its agricultural business to meet domestic demand and contribute to the worldwide market. Onion production provides money to farmers, stimulates rural economies, and helps local companies participate in the onion value chain [9].

The Philippines can ensure the continuity of its agricultural traditions, strengthen food security, and empower farming communities for a sustainable and prosperous future by promoting sustainable farming techniques, facilitating farmers' access to resources and markets, and celebrating the cultural richness of farming practices. One effective approach to preserving onion farming is through the research and creation of dance literature dedicated to capturing this agricultural practice's essence and cultural significance. According to the research conducted by Santos et al. [10], the establishment of a comprehensive dance literature has the potential to play a significant role in promoting and preserving cultural practices within the realm of agricultural labor. This observation underscores the profound impact that dance can have on the safeguarding and dissemination of agricultural traditions, as well as the potential benefits that can arise from recognizing dance as an invaluable cultural asset in the context of agriculture.

The domain of agriculture is characterized by a diverse array of cultural practices spanning a broad spectrum of activities, encompassing methodologies for cultivation, ceremonial observances for reaping, and collective festivities linked to the rhythms of agricultural cycles [11]. These practices often carry historical and cultural significance, reflecting a community or region's unique heritage and identity. In light of the swift modernization and globalization that societies are currently experiencing, there is a threat of traditional practices being forgotten. This is where the creation of dance literature can prove instrumental in preserving and promoting such cultural practices. Dance, as an expressive art form deeply rooted in culture, can encapsulate and transmit the essence of agricultural traditions [12]. Dance can capture the spirit, values, and rituals associated with agricultural labor through carefully choreographed movements, music, costumes, and storytelling elements. Documenting these dance forms and practices in a literary format provides valuable insights into the history, symbolism, and techniques involved. This creates a rich and accessible resource that can be shared with present and future generations, ensuring these cultural practices' longevity and continued relevance.

Many studies have documented folk dances associated with farming culture and practices [13]. The dance literature serves as a written and choreographic record that documents and honors the unique farming techniques, movements, rituals, and stories passed down through generations by delving into the rich history, traditions, and movements associated with farming or agricultural activities [14]. Previous studies on folk dance, farming and agricultural activities involved extensive study, interviews, and engagement with farmers [15]. The dance literature not only celebrates farming's past but also secures its survival by providing a forum for the distribution and appreciation of cultural heritage. It encourages a deeper awareness and respect of farming's crucial role in farmers' lives and its value within the broader framework of Philippine culture.

In creating dance literature, movement analysis is used to mimic and interpret diverse Philippine folk dances. This analytical method helps evaluate and comprehend the complicated motions of these cultural dances. Researchers have used a strategy similar to Mackenzie's [16], which entails characterizing the joint movements, the planes where the movements occur, and the specific muscles involved in completing the dance moves [17]. Researchers acquire insights into the biomechanics and kinematics of the dancers as a result of this systematic investigation, which improves our understanding of the technical features and creative expressions in popular traditional dances.

The existing research on onion farming in the Philippines has primarily focused on its cultural and economic significance and the documentation of folk dances associated with farming culture and practices [18]. However, there needs to be more research to understand the intricate connection between onion farming and the cultural practices and beliefs, traditional agricultural practices, and the social dynamics that shape this agricultural practice. Furthermore, a greater understanding of the specific physical demands and movement patterns involved in onion farming is needed to provide an accurate and culturally relevant movement analysis.

A research study on the cultural and movement analysis of onion farming in the Philippines can contribute to the

choreography of a folk dance that incorporates onion farming movements [19]. This research can provide insights into the unique movements and gestures associated with onion farming in the Philippines by analyzing the movement patterns involved. These movements can be incorporated into the choreography of a folk dance that celebrates the cultural traditions of onion farming and its essential role in the lives of smallholder farmers in the region. Moreover, the biomechanical analysis of farming movements can also guide for optimizing the movement patterns involved in folk dance, ensuring that they are safe and sustainable for performers [20].

Therefore, this study aimed to address these gaps by conducting an ethnographic and movement analysis of onion farming practices in the Philippines. The study will explore the cultural practices of onion farming through natural observation and immersion. Simultaneously, a biomechanical analysis will uncover the physical movements inherent in onion farming, ensuring the resulting movement analysis accurately reflects the authentic farming experience. Figure 1 shows the conceptual framework of the study.

2. Materials and Methods

2.1. Study Design

This study explored the cultural practices and movement analysis of onion cultivation in the Philippines using an ethnographic and biomechanical methodology. The study was conducted in the year 2021-2022 in two phases: first, an ethnographic analysis of onion farming practices was implemented, and second, a biomechanical analysis of the movements involved in onion farming was documented.

An ethnographic study on Philippine onion farmers through observation was the first part of the study. An ethnographic study is an appropriate design since it is a research method that entails the detailed and systematic analysis of a specific group, culture, or community through direct observation and participation in their daily lives to answer a research query based solely on the researcher's observations [21]. Furthermore, naturalistic observation was employed, which involves researchers seeing how participants respond to their surroundings in real-world circumstances without altering their behavior [22]. The observation focused on the cultural practices and beliefs linked with onion cultivation, such as traditional agricultural techniques and rituals. The social and cultural environment of onion growing, particularly the social organization of onion growers and their ties with the land, will be the focus of observations.

The biomechanical analysis was documented using the same method as other Philippine folk dances [23, 24, 25, 26]. This investigation relied on visual observation of the dance, in accordance with Mackenzie's [16] approach. The instructions presented in this document encompass three fundamental components. Firstly, they provide a comprehensive description of the precise movements that occur at the involved joints. Second, they specify the particular plane in which these movements occur. Lastly, they acknowledge the agonist and antagonist muscles responsible for generating both force and motion.

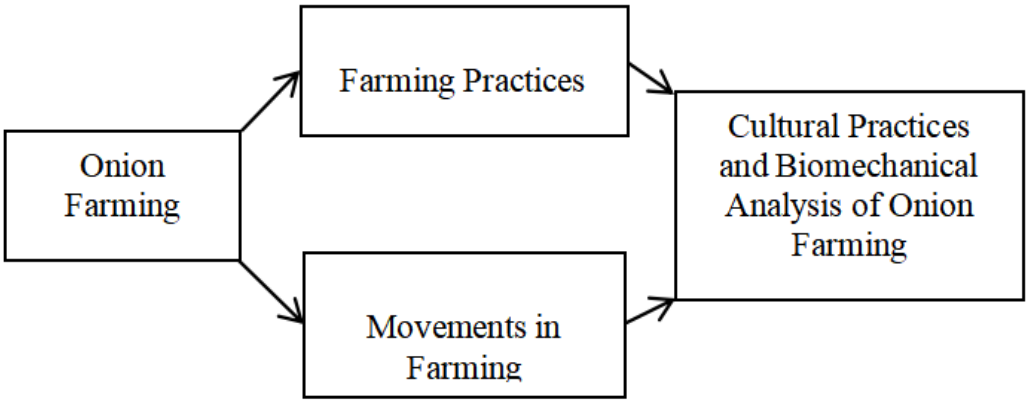

Figure 1. Conceptual Framework

2.2. Participants

This study utilized purposive sampling in selecting 20 onion farmers in Lupao, Nueva Ecija, Philippines as participants of the study. These participants were chosen based on criteria that included older and younger generations of onion farmers who have extensive experience in traditional onion farming. Furthermore, the selection of the participants was based on the recommendations of elder farmers. Elder farmers were crucial to the selection process since they understood onion farming's complexities. This participant selection approach matched the study's objectives and utilized the elder farmers' knowledge and experience to reflect Lupao's onion farming community well.

2.3. Instruments

Observation was conducted to collect data on the direct experience of the researchers focusing on the following aspects of onion farming such as cultural practices and beliefs, traditional agricultural practices, and the social dynamics of the farming community. Through naturalistic observation, the researchers observed how participants reacted to their surroundings in real-life situations, without any deliberate attempt to influence their behavior. This technique conforms to the approach outlined by Ciesielska et al. [22].

Mackenzie's [16] Movement Analysis Table served as the instrument for defining and analyzing the movements associated with onion cultivation. This procedure entailed describing the precise movements occurring at the involved joints, determining the plane in which these movements occurred, and identifying the agonist and antagonist muscles responsible for generating the necessary force for these movements. Martin and Miller [23], Martin and Santos [24], and Sanchez et al. [26] also cited these analytical principles in their respective works.

2.4. Procedure

In this study, ethical considerations were of the utmost importance, and all participating onion farmers in Lupao, Nueva Ecija were informed of the objectives of the research. Prior to commencing any observations or data collection activities, the researchers conducted informed consent sessions. The researchers provided participants with extensive information about the study's objectives, methodology, and potential implications of their participation. Participants were encouraged to ask questions and seek clarification as necessary in order to make an informed decision about their participation in the study. In addition, explicit permission was sought for the recording of observations, which was a crucial element of the ethnographic data collection.

During the observational phase of the investigation, video recording and detailed note-taking were employed. This dual strategy ensured exhaustive data collection. The video recording provided a visual record of the onion cultivation techniques, while careful note-taking captured context and subtle details that may not have been captured in the video. The recorded observations were then subjected to a comprehensive analysis of movement using the Mackenzie method. This analysis included a systematic evaluation of the video recordings to identify and document the specific farming practices and biomechanical aspects associated with onion farming. The combination of video recordings and detailed notes enhanced the depth and precision of the movement analysis, contributing to a comprehensive analysis of the cultural and physical dimensions of onion farming in the Philippines. The observation was then presented to the farmers in an observation report for their approval, and the biomechanical analysis was validated by experts in the related field of science of human movement.

2.5. Data Analysis

The data collected from the ethnographic part was analyzed using observational data reporting. The researchers began by documenting their onion cultivation observations. The reported data were subsequently interpreted based on relevant criteria, including cultural practices, agricultural practices, and the social dynamics of onion farming. The results were then presented and interpreted in light of the study's objectives.

Meanwhile, the biomechanical data was analyzed using the movement analysis table of Mckenzie [16]. The analysis focused on identified patterns in the movements and musculoskeletal activity in onion farming activities.

3. Results and Discussion

3.1. Observation Results

The objective of the naturalistic observation was to acquire a comprehensive understanding of the cultural practices and beliefs, traditional agricultural practices, and social dynamics of the onion farming community in Nueva Ecija, Philippines. By immersing themselves in the community, the researchers intended to document their distinctive practices, investigate the cultural significance of onions, and assess the sustainable agricultural techniques used.

3.1.1. Cultural Practices

Cultural practices play a significant role within the onion farming community in Nueva Ecija. The observations of the researchers revealed the profound relationship between these cultural elements and agricultural activities. The practice of requesting blessings from religious figures or local spiritual leaders is notable

in the observed cultural ritual of farmers in Lupao, Nueva Ecija. According to the farmers, to obtain divine intervention and favors for their onion crops, they visit sacred sites or churches. To assure the fertility of the land, favorable weather conditions, and protection from pests and diseases, they pray and perform rituals. This ritualistic element reflects the farmers' strong faith in the spiritual forces that regulate their agricultural endeavors and their desire to maintain a harmonious relationship with nature. Similarly, in an ethnographic study by Jocano [28] on "Rituals in Philippine Barrio," it was documented that farmers who planted rice and other staple crops perform rituals to interact with and influence supernatural beings for crop protection and abundant harvest. In addition, according to Mantikayan and Abas [29], in their study on Magindanawn farmers' rituals, rituals persist due to their strong faith in a Supreme Power, manifested in beliefs about the Supreme Power's competence in providing a successful harvest.

In addition, onion farming in Lupao, Nueva Ecija has been observed to be participated by young and elderly family members in their onion cultivation. The researchers' observations revealed the continuity of onion cultivation practices from generation to generation, indicating a strong family tradition of transmitting agricultural knowledge. It is common for parents to involve their children in various agricultural tasks, such as land preparation, sowing, and harvesting. Through this hands-on experience, the younger generation can learn the intricate techniques and skills required for successful onion cultivation. Studies corroborate this observation highlighting the significance of family tradition and hands-on experience in learning and perpetuating agricultural techniques and skills, underscoring the value of continuity and preservation of traditional farming methods in the face of rapid modernization [30, 31].

3.1.2. Agricultural Practices

Observations of onion farmers in Nueva Ecija by the researchers revealed a strong commitment to traditional agricultural practices by showcasing the Filipino values of "Bayanihan" and "Pakikisama." According to Ba et al. [32], this devotion to traditional farming methods is a widespread phenomenon that has been handed down through generations, highlighting the cultural significance of such methods. The focus of their research was the meticulous process of manually preparing the land, transplanting onion seedlings, and ultimately harvesting them. Thurston [33] emphasized that the labor-intensive nature of these traditional agricultural tasks indicates a deliberate decision to create optimal conditions for plant development, which reflects the farmers' deep-rooted expertise. Shack et al. [34] noted that these growers' attention to detail, such as precise seedling placement and meticulous harvesting, is the result of years, if not decades, of field experience.

In addition to meticulous planting, the onion farmers of Nueva Ecija emphasized organic agricultural practices. Although farming has been modernized, this group of onion farmers are still practicing old method of farming. This commitment to organic practices is consistent with the findings of Muhie [35], who reported that an increasing number of farmers worldwide are employing organic methods to preserve soil health and lessen the environmental impact of agriculture. According to Avery [36], the use of organic fertilizers such as compost and animal manure is done to preserve the soil. This decision, as discussed by Altieri [37], not only promotes sustainable agriculture but also contributes to the preservation of the region's natural ecosystem. As confirmed by Smith et al. [38], these farmers demonstrated their commitment to environmentally-friendly agricultural practices and their understanding of the long-term benefits of organic agriculture by minimizing their use of synthetic chemicals.

Moreover, the researchers' observations of onion farmers in Nueva Ecija revealed a strong commitment to traditional agricultural practices, including the use of carabaos for plowing, manual watering techniques, and the use of time-honored instruments and techniques. It is remarkable that the historical practice of onion farming has been retained and that mechanization technology like mechanical transplanters has not completely taken over onion production, although the study was conducted in 2021–2022. Roque [39] notes that the farmers' reliance on carabaos coupled with traditional plows exemplifies their resourcefulness and reverence for their agricultural heritage. According to Akrofiet et al. [40], their proficiency in manually watering the crops with watering cans demonstrates their profound comprehension of the terrain and their ability to deliver the precise amount of water for optimal onion growth. Ba et al. [32] concur that the farmers' use of traditional instruments such as rakes and sickles demonstrates their expertise and unwavering dedication to preserving their agricultural traditions. These practices demonstrate not only their adaptability and commitment to sustainable agriculture, but also their unwavering dedication to preserving their cultural heritage within the domain of onion cultivation.

3.1.3. Social Dynamics of the Farming Community

Researchers have observed that harmonious relationships flourish in the onion cultivation community of Nueva Ecija where individuals showed collaboration, sharing of information, and offering of assistance to one another. This sentiment of cooperation is exemplified by the tradition of "Bayanihan," as documented in Jack et al.'s [41] study. As supported by Pilar [42], community members voluntarily assist one another with labor-intensive tasks, which fosters a profound sense of togetherness and unity among them. This spirit of teamwork is exemplified by during crucial agricultural processes such as land preparation, planting, and harvesting. This lightens the burden and strengthens the

bonds between farmers.

In addition to their collaborative efforts and structured organization, the onion farming community in Nueva Ecija has been observed to be engaged in informal gatherings and communal leisure activities that foster camaraderie and relaxation, as observed by the researchers. During agricultural work breaks, they gather for relaxation, engaging in activities such as smoking, dining, and casual conversation. As explained by Shrestha [43], this practice functions to strengthen social bonds and provide a much-needed break from their laborious tasks by engaging in farming activities as a form of recreation. Also, after a hard day of farming, they unwind by sharing drinks, listening to stories, and enjoying each other's company, a tradition that not only serves as a form of celebration but also plays a crucial role in strengthening their social fabric, cementing their bonds, and providing vital emotional support within the close-knit community. This is similar to the findings of Liu et al. [44] that agricultural activities foster community attachment.

Furthermore, the researchers have observed that the onion producers of Nueva Ecija have a strong sense of familial cooperation. Together, husbands and wives work in the fields, with wives providing essential support by serving water and preparing snacks during shared pauses. These pauses not only provide moments of relief, but also provide family members with opportunities to interact, discuss various topics, and strengthen their familial bond. Additionally, the active participation of children in agricultural activities demonstrates the intergenerational transmission of knowledge and the development of a strong work ethic within the family.

Involving family members in the agricultural process fosters a communicative environment that promotes mutual understanding and strengthens familial ties. The onion farming community of Nueva Ecija serves as a vivid example of the profound significance of family dynamics in preserving their agricultural traditions and nurturing a sense of community through their collaborative efforts and meaningful interactions. This family-centered approach to farming is consistent with the findings of Grubbstrom and Soovali-Sepping [45], who emphasized the importance of family dynamics in agricultural practices.

3.2. Biomechanical Analysis

The farming movements of onion farmers were analyzed using the Mckenzie [16] movement analysis table. The movements were grouped into 3 major parts based on the observed farming stages such as Panangisagana (Land Preparation), Panagimula iti bin-i (Planting of Seedling), and Panaggaapit (Harvesting). The analyzed movements were validated by the onion farmers, experts from the field of agriculture, and experts in kinesiology and biomechanics.

3.2.1. Panangisagana (Land Preparation)

The initial phase of onion cultivation is known as "Panangisagana" or Land Preparation and consists of four steps: "Panagaradu" (Plowing), "Panagkaraykay" (Raking), "Pagsidsid" (Leveling of Soil Bed), and "Warakiwak" (Sprinkling of Smooth Soil). The first stage, "Panagaradu" (Plowing), utilizes a metal plow with a long, pointed, and sharp design. According to Agrivi [46], this tool is essential for the initial cultivation of soil prior to seed sowing or seeding. In the Philippines, the carabao, affectionately referred to as the farmer's best companion, is frequently employed for plowing. The second phase, "Panagkaraykay" (Raking), requires the use of a "Piruya" or rake, which consists of a row of metal or wooden teeth affixed to a bar or frame. According to AgriExpo [47], this versatile tool serves a variety of purposes, such as piling hay or grain, clearing fields, lawns, and yards, and combining and disseminating soil. The third phase, "Pagsidsid" (Flattening of Soil Bed), focuses on leveling the farmland to assure a more uniform distribution of rain or irrigation water across the field and to reduce runoff. According to Sciencedirect [48], this task is accomplished using a leveling tool made from weighted, squared timber with handles. The final step is "Warakiwak" (Sprinkle of Smooth Soil), in which refined soil is applied to create a flat, stable bed that is suitable for sowing onion seeds. This step guarantees optimal conditions for successful onion seed planting.

3.2.1.1. Panagarado (Plowing)

The movement analysis of onion cultivation during the initial phase of land preparation, known as "Panangisagana" or Land Preparation, with a focus on "Panagaradu" or Plowing, is presented in Table 1. In this analysis, a number of significant movements were observed. First, at the ball-and-socket shoulder joint, flexion was identified as the joint movement. In the sagittal plane, the anterior deltoid functions as the agonist, while the posterior deltoid functions as the antagonist. As a hinge joint, the elbow exhibited flexion in the sagittal plane, with the biceps and triceps functioning as the agonist and antagonist muscle groups, respectively. Second, the hip joint exhibited flexion in the sagittal plane, with the gluteus maximus serving as the antagonist and the iliopsoas as the agonistic muscle. Third, at the knee joint, a hinge joint, flexion in the sagittal plane was seen, in which the hamstrings muscles functioned as the agonist and the quadriceps muscles functioned as the antagonist. Dorsiflexion was detected at the ankle joint, a hinge joint, in the sagittal plane. The tibialis anterior muscle acted as the agonist, while the gastrocnemius and soleus muscles functioned as the antagonists. Notably, this movement analysis is similar to Martin and Miller's [23] findings.

Table 1. Movement analysis of Panagaradu (Plowing)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Shoulder	Ball and Socket	Flexion	Sagittal	Anterior Deltoid	Posterior Deltoid
Elbow	Hinge	Extension	Sagittal	Triceps	Biceps
Hip	Ball and Socket	Flexion	Sagittal	Iliopsoas	Gluteus Maximus
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

Table 2. Movement analysis of Panagkaraykay (Raking)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Shoulder	Ball and Socket	Protraction & Retraction	Sagittal	Serratus Anterior & Pectoralis Major	Trapezius, Rhomboids, and Latissimus Dorsi
Hip	Ball and Socket	Flexion	Sagittal	Iliopsoas	Gluteus Maximus
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

3.2.1.2. Panagkaraykay (Raking)

The movements involved in onion cultivation during the Panangisagana (Land Preparation) phase of Panagkaraykay (Raking) are analyzed in Table 2. Firstly, within the sagittal plane, the shoulder joint endures protraction and retraction motions. The serratus anterior and pectoralis major are the primary muscles responsible for these actions, while the trapezius, rhomboids, and latissimus dorsi function as antagonistic muscles. Secondly, flexion occurs in the sagittal plane at the ball-and-socket hip joint. In this case, the gluteus maximus functions as the antagonistic muscle, while the iliopsoas serves as the agonistic muscle. Thirdly, in the sagittal plane, flexion is observed at the hinge-like knee joint. The agonistic muscle group for this movement is the hamstring, whereas the antagonistic muscle group is the quadriceps. Fourth, in the sagittal plane, dorsiflexion occurs at the ankle joint, which is also hinge-like in character. The anterior tibialis is the agonist, while the gastrocnemius and soleus are antagonists. Notable similarities exist between this analysis and the analysis of Cantergi et al. [25].

3.2.1.3. Pagsidsid (Flattening of Soil Bed)

Table 3 outlines the analysis of movements involved in onion cultivation during the Panangisagana (Land Preparation) phase in Pagsidsid (Flattening of Soil Bed). Initially, at the shoulder joint, sagittal motion involving elevation and depression occurs initially. In this action, the anterior deltoid is the agonistic muscle and the latissimus dorsi is the antagonistic muscle. Second, at the frontal plane with the elbow joint, a hinge joint, extension is observed. In this case, the agonistic muscle group consists of the triceps, whereas the antagonistic muscle group consists of the biceps. Third, flexion is performed at the joint of the knee classified as a hinge joint in the sagittal plane. The muscles involved in this movement consist of the hamstring group as agonist and the quadriceps group as antagonist. Finally, dorsi flexion takes place in the sagittal plane at the ankle joint, which is classified as a hinge joint. The anterior tibialis muscle assumes the role of the agonist, whilst the gastrocnemius and soleus muscles work as the antagonist muscles. Notably, these findings corroborate the analysis by Sanchez et al. [26].

Table 3. Movement analysis of Pagsidsid (Flattening of Soil)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Shoulder	Ball and Socket	Elevation Depression	Frontal	Anterior Deltoid	Latissimus Dorsi
Elbow	Hinge	Extension	Frontal	Triceps	Biceps
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

Table 4. Movement analysis of Warakiwak (Sprinkle of Smooth Soil)

Joint	**Joint Type**	**Movement Allowed**	**Plane**	**Agonist**	**Antagonist**
Elbow	Hinge	Flexion	Sagittal	Biceps	Triceps
Wrist	Condyloid	Flexion	Sagittal	Wrist Flexors	Wrist Extensors
Hip	Ball and Socket	Flexion	Sagittal	Iliopsoas	Gluteus Maximus
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

3.2.1.4. Warakiwak (Sprinkle of Smooth Soil)

Table 4 provides a comprehensive analysis of onion cultivation movement during the Panangisagana (Land Preparation) phase in Warakiwak (Sprinkle of Smooth Soil). First, this pattern is repeated at the elbow hinge joint, with the biceps acting as the agonistic muscle group and the triceps acting as the antagonistic muscle group. Second, the condyloid wrist joint exhibits flexion in the sagittal plane, where the wrist flexors function as agonists and the wrist extensors function as antagonists. Third, forward flexion at the ball-and-socket hip joint occurs in the sagittal plane, with the gluteus maximus operating as the antagonist and the iliopsoas as the agonist muscle. Fourth, at the hinge-like knee joint, further along the sagittal plane, flexion is driven by the hamstrings as agonists and the quadriceps as antagonists. Fifth, in the sagittal plane, dorsiflexion occurs at the ankle joint, another hinge joint, with the anterior tibialis as the agonist and the gastrocnemius and soleus as the antagonists. Morris et al. [27] conducted a comparable analysis of the movements in their study.

3.2.2. Panangimula (Planting)

The second phase of onion cultivation is called the "Planting" or "Panangimula" stage. This stage is comprised of a specific sequence of actions, including "Pangisabog" (Sprinkling of Seeds), "Pagbudbud ng Ipa" (Sprinkling of Rice Husk), "Panagsibog" (Showering), "pannaggab-ut" (Pulling of Seedlings), and "Panagimula iti bin-i" (Planting of Seedlings). To initiate germination, "Pangisabog," or the Sprinkling of Seeds, is performed initially. This is the essential procedure through which various plant species develop from a single seed into a mature plant. The next step is "Pagbudbud ng Ipa," which utilizes rice fiber. Rice husk is the grain or kernel's protective covering. Rice fiber that has been fermented is utilized as a soil amendment or organic fertilizer due to its high water retention capacity [50]. The third stage, "Panagsibog" or Showering, involves watering the bed soil with handheld sprinklers. This is followed by "pannaggab-ut," which refers to the process of transplanting seedlings by drawing them up [51]."Panagimula iti bin-i" or Planting of Seedlings is the final step of the planting procedure. In this phase, onion seedlings are transplanted into the prepared soil bed.

3.2.2.1. Pangisabog (Sprinkling of Seed and Rice Husk)

Table 5 depicts the motion analysis of onion cultivation during the "Pangisabog" phase, which includes the actions of Seed Sprinkling and Rice Husk Spreading. These movements are identical between the two activities.The primary motion observed is flexion, occurring within the sagittal plane at the hinge joint of the elbow. The movement in question is predominantly executed by the biceps, which act as the agonistic muscle group, whereas the triceps serve as the antagonistic muscle group. The second movement involves condyloid wrist joint flexion, which also occurs in the sagittal plane. In this case, the wrist flexors are agonistic, while the wrist extensors are antagonistic. The third movement is flexion of the hip ball-and-socket joint in the sagittal plane. The gluteus maximus is the antagonistic muscle and the iliopsoas is the agonistic muscle in this situation. During the fourth movement, the knee joint, which is a hinge joint, flexes in the sagittal plane. The hamstrings are responsible for this flexion movement as the agonistic muscle group, while the quadriceps serve as the antagonistic muscle group. Fifth, dorsiflexion was observed in the sagittal plane, which is a movement at the ankle joint classified as a

hinge type of joint. In the context of dorsiflexion, the tibialis anterior muscle serves as the agonist, while the gastrocnemius and soleus muscles function as the antagonists. Notably, Ahonen et al. [49] performed a comparable analysis of these movements in their study.

3.2.2.2. Panagsibog (Showering)

Table 6 provides an analysis of the movements involved in onion cultivation during the "Panagsibog" phase, which is the Showering activity. The initial movement identified in the frontal plane at the elbow, a hinge joint, is horizontal extension. In this action, the middle deltoid muscle serves as the agonist, whilst the latissimus dorsi muscle functions as the antagonist. Second, flexion was determined at the knee joint, which is classified as a hinge joint, inside the sagittal plane. In this particular movement, the muscle group of the hamstrings functions as the agonist, while the muscle group of the quadriceps serves as the antagonist. Third, dorsiflexion was observed at the ankle joint, which is a hinge joint, inside the sagittal plane. The tibialis anterior muscle functions as the agonist, and the soleus and gastrocnemius muscles as antagonists. This result corroborated Sanchez et al.'s [26] study.

Table 5. Movement analysis of Sprinkling of Seed and Pagbudbud ng Ipa (Sprinkling of Rice Husk)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Elbow	Hinge	Flexion	Sagittal	Biceps	Triceps
Wrist	Condyloid	Flexion	Sagittal	Wrist Flexors	Wrist Extensors
Hip	Ball and Socket	Flexion	Sagittal	Iliopsoas	Gluteus Maximus
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

Table 6. Movement analysis of Panagsibog (Showering)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Elbow	Hinge	Horizontal Extension	Frontal	Middle Deltoid	Latissimus Dorsi
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

Table 7. Movement analysis of Panaggabot (Pulling of Seedlings)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Elbow	Hinge	Flexion & Extension	Sagittal	Biceps for Flexion Triceps for Flexion	Triceps for Flexion Biceps for Flexion
Wrist	Condyloid	Abduction	Frontal	Extensor carpi radialis longus, extensor carpi Radialis brevis, Abductor pollicis longus and Flexor carpi radialis	Flexor carpi ulnaris and Extensor carpi ulnaris

3.2.2.3. Panaggabot (Pulling of Seedlings)

Table 7 provides an analysis of the movements involved in onion cultivation during the "pannaggab-ut" phase, which includes the "Pulling Seedlings" activity. First, within the sagittal plane, both flexion and extension motions may be observed at the elbow regarded as a hinge joint. During flexion of the elbow, the biceps muscular group functions as the agonist, while the triceps muscle group serves as the antagonist. On the contrary, the triceps muscle group functions as the primary agonist responsible for extension, whilst the biceps muscle group acts as the antagonist in this movement. Second, the wrist joint performs abduction in the frontal plane. For the abduction of the wrist joint, Extensor carpi radialis longus, extensor carpi Radialis brevis, Abductor pollicis longus and Flexor carpi radialis act as agonist muscles while Flexor carpi ulnaris and Extensor carpi ulnaris are regarded as antagonistic muscles. Sanchez et al. [26] reported a comparable analysis.

3.2.2.4. Panagimula iti bin-i (Planting of Seedling)

Table 8 provides an analysis of the movements involved in onion cultivation during the "Panagimula iti bin-i" phase, which centers on the Planting of Seedlings. First, flexion is the primary motion observable in the sagittal plane at the elbow, classified as a hinge joint type. The elbow flexion action is aided by the agonistic muscle group which is the biceps brachii. Meanwhile, the triceps brachii muscle group serves as the antagonistic counterpart responsible for elbow extension. Second, it is worth noting that flexion occurs in the sagittal plane specifically at the condyloid wrist joint. The wrist flexors muscles act as agonist while the wrist extensors muscles act as antagonists and are responsible for the movement of wrist extension. Third, flexion of the knee joint occurs in the sagittal plane, which is categorized as a hinge joint type. The hamstrings belong to the agonistic muscle group, while the quadriceps belong to the antagonistic muscle group. Fourth, dorsiflexion takes place in the sagittal plane at the ankle joint, which is anatomically categorized as a hinge joint. The tibialis anterior muscle is responsible for executing the agonistic action, whereas the gastrocnemius and soleus muscles function as antagonists. The results of this investigation are comparable with the findings of Cantergi et al. [25].

3.2.3. Panaggaapit (Harvesting)

The third stage of onion farming is the Panaggaapit (Harvesting). This stage has one distinct movement being executed which is called Panaggaapit (Scooping-Harvesting). In the Panaggaapit the onions are being pulled out from the soil for the harvest.

3.2.3.1. Panaggaapit (Scooping-Harvesting)

The movement analysis of onion cultivation during Panaggaapit (Scooping-Harvesting) is presented in Table 9. First, the elbow joint, categorized as a hinge joint, performs flexion. The observed movement is executed in the sagittal plane. In addition, the biceps brachii is the muscle group acting as agonist, responsible for flexion, while the triceps brachii is the antagonist muscle group executing extension. Second, flexion movement of the wrist joint, a condyloid joint, takes place in the sagittal plane. The agonistic muscle group responsible for wrist flexion is the wrist flexors, while the antagonistic muscle group responsible for wrist extension is the wrist extensors. Third, flexion is executed in the sagittal plane at the knee joint, which is categorized as a hinge joint. The hamstrings act as agonistic muscle group while the quadriceps act as an antagonistic muscle group. Fourth, the ankle joint is executed, which is classified as a hinge joint, executes the dorsiflexion where the tibialis anterior is an agonist in this context, whereas the gastrocnemius and soleus are antagonists. This aligns with the analysis reported by Koutedakis et al. [52].

Table 8. Movement analysis of Panagimula iti bin-i (Planting of Seedling)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Elbow	Hinge	Extension	Sagittal	Biceps	Triceps
Wrist	Condyloid	Flexion	Sagittal	Arm Flexors	Wrist Extensors
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

Table 9. Movement analysis of Pagtatanim ng Binhi (Scooping-Harvesting)

Joint	Joint Type	Movement Allowed	Plane	Agonist	Antagonist
Elbow	Hinge	Flexion	Sagittal	Biceps	Triceps
Wrist	Condyloid	Flexion	Sagittal	Arm Flexors	Wrist Extensors
Knee	Hinge	Flexion	Sagittal	Hamstring	Quadriceps
Ankle	Hinge	Dorsi Flexion	Sagittal	Tibialis Anterior	Gastrocnemius / Soleus

4. Conclusions

This study provides a comprehensive examination of the onion farming community in Nueva Ecija, Philippines, offering valuable insights into its dynamics and characteristics. The interplay between cultural practices, traditional agricultural methods, and social dynamics is crucial in shaping the vibrant fabric that defines this community. The customs and traditions present within the local community serve as a manifestation of their abundant cultural heritage and wisdom. Moreover, these customs and traditions play a crucial role in cultivating a deep sense of unity among community members. Consequently, this unity contributes to the long-term viability and endurance of their farming practices. The presence of spiritual connections to the land and farming activities is clearly demonstrated through the observance of rituals aimed at ensuring a plentiful harvest and safeguarding against potential environmental hazards. The enduring transmission of agricultural knowledge and techniques from one generation to another serves as a testament to the influential role of familial traditions in safeguarding cultural heritage and advancing the cause of sustainable farming practices.

The unwavering dedication exhibited by farmers towards adhering to traditional agricultural practices, such as manual planting, organic farming, and the utilization of conventional tools, serves as a testament to their resolute commitment to sustainable agriculture and the safeguarding of cultural heritage. The utilization of carabaos for plowing and manual watering methods by the individuals in question serves as a testament to their profound understanding of the land and the ideal circumstances required for the successful cultivation of onions. The farming community exhibits a strong sense of collaboration and collective support, as exemplified by the practice of "Bayanihan." The promotion of unity and solidarity is facilitated by the longstanding tradition of community members providing assistance to one another in farming endeavors. The engagement in collective recreational pursuits and social assemblies serves as a source of emotional solace, fortifies interpersonal connections, and grants respite from arduous endeavors.

Meanwhile, the biomechanical analysis identified prominent movements across three critical stages of farming: Panangisagana (Land Preparation), Panangimula (Planting), and Panaggaapit (Harvesting). The prominent joint movements are flexion and extension of the shoulder, elbow, wrist, hip, knee and ankle, which are dominant in the sagittal plane. The major muscles of the shoulder, arm, forearm, and legs were prominent in the farming movements in a pair or agonistic and antagonistic muscle action. The movements serve as a demonstration of the intricate coordination between various muscle pairs, thereby highlighting the physically demanding nature of onion farming. The aforementioned findings serve to emphasize the necessity of implementing ergonomic interventions in order to enhance work efficiency and ensure the well-being of farmers.

The research presented herein serves as a testament to the significance of safeguarding customary practices while prioritizing the welfare of those who engage in them, thereby intricately connecting cultural heritage and biomechanics. Also, this paper could also serve as a basis for the creation of a dance literature on onion farming.

Acknowledgements

The researchers extend their deepest gratitude to the committed onion farmers of Lupao, Nueva Ecija, whose participation and insightful contributions were indispensable to the success of this investigation. Their generosity in sharing their knowledge and on-the-ground experiences has greatly improved our understanding of onion cultivation practices in the Philippines. The researchers would also like to express their appreciation to the esteemed specialists whose expertise and meticulous validation were instrumental in bolstering the credibility and rigor of this study. Their invaluable contributions were instrumental in maintaining the study's quality. In addition, the researchers are grateful to Mrs. Yolanda Valencia, the English expert, for her meticulous review of the paper. Her careful attention to detail elevated the overall quality of our work by ensuring the paper's clarity, grammar, and language. Most importantly, the researchers would like to express their profound appreciation to Central Luzon State University for their generous financial support, which made it possible to conduct this research. Dr. Edgar A. Orden, President of the University, deserves special recognition for his unwavering support and provision of this opportunity, which have fueled the researchers' pursuit of their passion for research.

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