INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Exploring Innovative Design Solutions for Pineapple Harvesting in the Context of Northeast India

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SHORT ABSTRACT

Pineapple (*Ananas comosus*) is the third most important tropical fruit globally, following banana and citrus. India ranks second in pineapple cultivation (0.11 million hectares) and seventh in production (1.80 million tonnes). Despite its importance, India faces challenges with low productivity (16.81 tonnes per hectare) compared to global leaders like Indonesia (127.29 tonnes per hectare). The northeastern states of Assam, Manipur, Meghalaya, Tripura, and Nagaland are among the top pineapple cultivators, with more than half of the country's total production cultivated organically. The pineapple crop is essential to the region's agriculture and economy. However, the cultivation practices in northeast India involve traditional methods, primarily on hilly terrain under rain-fed conditions. Though preserving fruit quality, the practice of manual harvesting poses labour intensiveness, time consumption, and ergonomic hazards, leading to health issues among farmers. Despite attempts to mechanize harvesting in other major pineapple-producing countries, the rugged, hilly terrain and traditional practices make large machinery impractical in northeast India. The unique challenges of northeast India require tailored solutions, possibly involving ergonomically designed, manually operated tools to address the prevalent issues and improve harvesting efficiency. Therefore, addressing the challenges in cultivation practices and manual harvesting methods through targeted research and interventions is vital to enhance productivity, reduce drudgery, and improve the overall well-being of pineapple farmers in the region.

Keeping the above discussion in mind, this research focuses on the challenges faced by pineapple farmers in northeast India, particularly in terms of working conditions, the prevalence of musculoskeletal disorders (MSDs), the manual harvesting process, and associated ergonomics risk factors. This research aimed to investigate the socio-demography of pineapple farmers and problems associated with pineapple harvesting tasks and to develop innovative design solutions adoptable for the needs of pineapple farmers in northeast India. To achieve the aim following objectives have been laid down.

- Objective 1: To assess the socio-demography of pineapple farmers, working conditions, and problems associated with pineapple harvesting tasks in northeast India
- Objective 2: To explore innovative design solutions for ease and safe pineapple harvesting in the context of northeast India
- Objective 3: To develop and evaluate the performance of the prototype pineapple harvester from an ergonomic perspective
- Objective 4: To study the effect of newly developed harvester on productivity, efficiency and manual labour

The present study highlights a systematic research methodology that begins with a literature review and a field survey to determine the research gap and scope for executing the doctoral research. Qualitative and quantitative research approaches were implemented based on the needs of data gathering. This research has shown how to use a pre-tested schedule and SNQ questionnaire for data collection and to determine the need for proper ergonomic intervention followed by direct observations (photography and videography) to identify ergonomic stressors during the field study. Postural load evaluation using REBA, mapping of body parts discomfort, quantification of energy requirement, and oxygen consumption rate based on heart rate were executed in this study. The System Usability Scale (SUS) was used as a reliable tool for measuring usability.

The study involved 152 pineapple farmers in total (92 men and 60 women). Data were collected using a pre-tested structured schedule and a standard Nordic questionnaire through in-person interviews and direct observation. The study thoroughly analyses the socio-demographic traits, working conditions, and related issues by integrating cutting-edge equipment and harvesting methods. The pineapple farms were located in remote areas without direct access to electrical power, posing challenges to adopting motorized harvesting equipment. The study emphasized the need for context-specific tools and equipment, considering the available farm power in the region. The prevalence of MSDs among pineapple farmers was higher than reported in other agricultural studies, with the lower back being the most affected body part. Demographic factors such as age, education level, and farming experience were significantly associated with the prevalence of MSDs, highlighting the importance of education and training for farmers. Ergonomic stressors such as bending, twisting, repetitive work, and carrying heavy loads contributed to MSDs. In

addition to identifying ergonomic stressors, the study addressed the issues in pineapple harvesting tasks through a systematic research approach. This thesis included extensive work in this area, carefully examining the frequency of issues linked to occupational health, including musculoskeletal illnesses, and evaluating ergonomic risk factors.

The present research employed design thinking and a user-centric design approach and explored the feasibility of developing a pineapple harvesting device, considering crop, user, and machine parameters. A full-scale prototype of a pineapple harvesting device was developed, incorporating features such as a fruit grabber and cutting blade. Field trials and evaluations were conducted at farmers' farms to assess the targeted users' performance, usability, and acceptability. The SUS was also applied during pineapple harvesting activities by both existing traditional methods and newly developed pineapple harvester to demonstrate the newly developed pineapple harvesting device's effectiveness compared to the conventional method. The study revealed that the developed pineapple harvester has the potential to improve various aspects of the harvesting process, including physiological parameters, ergonomic impact, productivity, and usability. It was proved that the newly developed pineapple device helped to avoid awkward working postures and injury from leave tips and spines and reduced drudgery significantly, thereby improving the productivity and efficiency of the pineapple harvesting process.

From a societal perspective, this study has focused on addressing practical challenges and ergonomic concerns related to harvesting pineapples in northeast India. This region is characterized by hilly terrains where small and marginal farmers cultivate pineapples for their livelihoods. Unfortunately, pineapple farmers in the northeast are constrained by outdated harvesting tools due to limited fabrication resources, insufficient research initiatives, and geographical barriers. Given this context, there is a pressing need to create innovative tools tailored to the occupational safety requirements of northeast India. A novel harvesting device resulting from this study ensures the well-being of farmers and mitigates ergonomic challenges. Through a systematic design and development process, the intervention markedly improved working postures and reduced ergonomic risks. The large-scale production and deployment of such devices for pineapple harvesting is anticipated to profoundly impact the lives of disadvantaged pineapple farmers in northeast India. The availability of fully developed, locally manufactured industrial products of this nature will likely garner significant acceptance within northeast India, benefiting the targeted community substantially.