IN-PLANT TRAINING REPORT

ON

FARM MACHINERY & POWER

AT

ICAR-CENTRAL INSTITUTE FOR WOMAN IN AGRICULTURE
BHUBANESWAR, ODISHA

01-07-2018 TO 30-09-2018

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Centurion UNIVERSITY
Shaping Lives... Empowering Communities

4TH YEAR B.TECH (AG-ENGG)

SCHOOL OF ENGINEERING & TECHNOLOGY,

CENTURION UNIVERSITY OF TECHNOLOGY AND MANAGEMENT

PARALAKHEMUNDI, ODISHA

PREFACE

SUCCESS IS WALKING FROM FAILURE TO FAILURE WITH NO LOSS OF ENTHUSIASM

Man gains knowledge from practical experiences and this signifies; how a practical is differing from the general education. It is the training which makes the trainees to gain knowledge and have a deep penetration to the various aspects while working,

We had an excellent training on Farm machinery and Power in ICAR-CIWA, Bhubaneswar from 1st July to 30th September .This is only one institute devoted to gender related research in agriculture .

During this three month we gained a lot of practical knowledge about ergonomics, some of farm machinery implements and tools, post-harvest technology on fruits, occupational health hazard.

All the scientists & the technical staffs of this research institute helps us whole heartedly. Without their cooperation, hard work & encouragement, our training would have been incomplete. All the staffs and & employees of this institute were very cordial towards us.

This three month practical training was a real opportunity for a break through practical field indeed and it will be one of the memorable parts in carriers as well as in our life.

ACKNOWLEDGEMENT

We the two trainees of SOET, CUTM, Paralakhemundi articulate our deep sense of gratitude to our honourable DEAN Dr. B. P. Mishra, the training in charge officer Er. Subodh Tanay Panigrahi and Dy. Register (placement) Mr. S. Kameswar Rao for arranging such an excellent research centre for our in-plant training.

We are highly indebted and thankful to the Director ICAR-CIWA for permitting us to acquire practical experience at this institute. We express our cordial thanks to Er. Chaitrali S. Mhatre, Scientist (FMP) and for her encouragement, guidance, love, affection and also support during training period.

We are grateful to Dr Jyoti Nayak (Principle Scientist, FRM), Dr. J. Charles Jeeva (Principal Scientist, Agricultural Extension), Dr. Ananta Sarkar (Senior Scientist, Agricultural Statistics), Mrs. Ankita Sahu (Scientist, Fruit Science) for their consistent cooperation and excellent teaching during the training.

We extend our sincere thanks to Er. Pragati Kishore Rout, Technical Assistant (FMP) for his support and for being there to share our joys and sorrows.

We are thankful to Er. Gayatri Mohanty, SRF scholars of our lab for their help and support when we needed it most.

We express our sincere thanks to various staff members of ICAR-CIWA, for their continuous cooperation to make our training a very enjoyable and unforgettable one.

Last but not the least, I express my gratitude and love to my family, for their constant encouragement, care and help.

Thanks a lot to GOD, whose help is always sought before my work.

(Ardhendu Sekhar Satapathy) **(Mohan Mondal)**

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INTRODUCTION

ICAR- Central institute for woman in agriculture (ICAR-CIWA) is an institution first of its kind in India that is exclusively devoted to gender related research in agriculture. It is established as National Research Centre for Women in Agriculture (NRCWA) in April 1996 at Bhubaneswar (Odisha) under Indian Council of Agricultural Research, New Delhi. The directorate has been upgraded and renamed as" ICAR- Central institute for woman in agriculture (ICAR-CIWA)" in the year 2014 under XIIth plan EFC.

Mission:

Generate and disseminate knowledge to promote gender sensitive decision making for enhancing efficiency and effectiveness of woman in agriculture.

Vision:

Emerge as a leading centre for gender research and serve as a catalyst for gender mainstreaming and women empowerment in agriculture to realize enhanced productivity and sustainability of agriculture.

Mandate:

- Research on gender issues in agriculture and allied fields.
- Gender-equitable agricultural policies/ programmes and gender-sensitive agricultural-sector responses.
- Co-ordinate research on Home Science.

ORGANISATIONAL STRUCTURE:

Research Divisions

1. Agricultural Economics
2. Agricultural Entomology
3. Agricultural Extension
4. Agricultural Statistics
5. Agronomy
6. Farm Machinery and Power
7. Fish Processing Technology
8. Home Science

9. Livestock Production and Management
10. Vegetable Science /Horticulture

All India Coordinated Research Project:

The AICRP on Home Science was conceived as an instrument to develop a strong base of research and extension the State Agricultural Universities for improving the quality of life of rural families. The project was initiated during the VI Five Year Plan Period. However, it is merged with DRWA in XI Five Year Plan Period. AICRP on Home Science integrates all the five components of Home Science in it namely Foods and Nutrition, Clothing and Textiles, Family Resource Management, Human Development & Family Studies and Home Science Extension Education. Each discipline has a specific thrust area of research that has been knitted together to focus on empowerment of women in agriculture for enhancing their quality of life. At present, the AICRP on Home Science is being implemented through its **ten centres** located in different State Agricultural Universities of the country viz.

Ongoing Research Projects

- Engendering Agricultural Research and Extension through Gender Friendly Technology Hub
- Developing gender sensitive model for Doubling Farmers' income by addressing gender concerns and technological gaps
- Strengthening gender knowledge system in Agriculture
- Seed Production of Food Crops in Tribal Regions with Participation of Women
- Optimizing technological interventions with gender perspective in small scale mango orchards
- Drudgery Reduction of Women Involved in Fish Processing through Technological Interventions
- Livelihood improvement of tribal farm women through secondary agriculture
- Design and development of disc type ridger for farmwomen
- Development and evaluation of integrated floating cage aquageoponics system for small scale Women pond holders
- Performance evaluation of selected farm tools and implements in gender perspective for operational and ergonomic parameters

- Mapping livestock and gender and studying the role of institutions in livestock development in Eastern India
- Status of Women in Peri-urban Dairy Farming : Mainstreaming their Role for Enhancing Income and Productivity
- Gender inclusive homestead aquaculture for enhancing household fish consumption and income
- Promoting gender equity through family poultry production
- Enhancing income of rural women through improved goat rearing
- Improving availability of quality pulse seed with participation of women
- Exploratory study on nutritional status of Nabarangpur district, of Odisha (Inter Institutional Project with Regional Station CTCRI, Bhubaneswar)

Extension Education developed out of multidisciplinary approach. It intends to serve farming communities providing latest technologies to increase status of livelihood of the farm women and farmers. Extension in ICAR-CIWA reaches and teaches women target group to lead quality life keeping harmony with environment in which they reside and work. It takes care of capacity building, skill improvement creating self confidence and enabling farm women to take right position in nation building process. ICAR-CIWA sincerely organizes various extension activities like Field Days, Exhibitions, Exposure visits, Demonstrations, TOT through Mass Media, etc. to acquaint the farm women with latest technologies. The Institute also conducts various capacity building programmes for gender sensitization among various stakeholders and to bring a change in knowledge, attitude and skill of farm women.

Gender friendly extension approaches and methodologies:

- Village Level Para Extension Workers (VPEW) Model
- Public Private Partnership (PPP) Model

Participatory action research in Crop Production, Crop Protection, Horticulture, Animal Sciences, Fisheries:

- Technology Demonstration
- Farm Women Training

ROLE OF WOMEN IN AGRICULTURE

- Woman, who has given birth to agriculture
- Represent 43% of global agricultural labour force
- In India, 65% of economically active women are in agriculture.
- Devote 45 - 50% of their time to agricultural activities
- Women spend 354 min/day and men 36 min/day on household activities
- About 12% of rural households are women-headed-with small holdings
- Alarming number of farmer suicides
- Male migration - About 40% of the men want to quit farming
- Gender role transformation in agriculture
- Struggling to attain Sustainable Development Goals of..
- No Poverty
- Zero Hunger
- Good Health & Wellbeing
- Climate Action
- Gender Equality

Issues of women agriculture laborers

- Dawn to dusk hard labour
- Deprivation of child
- Low wage rate
- Seasonal employment
- Insecurity at work place
- Addiction to tobacco and local liquor
- Travelling to distant places for farm work
- Worst sufferers of natural calamities
- Lack of exposure/training
- Nutrition deficiency

Development of women leadership in agriculture…

- Women need the support and help of a women leader who would organize them to be bold enough in facing socio-cultural restrictions, economic backwardness, the developmental agents, risks and complex technologies

- Often they need a woman leader who can read and write and keeps the accounts of the enterprises
- The training and extension for women and ATMA model have encouraged group activities among women, train them, and leave the group to function under a women leader

Extension strategies for addressing gender issues...

- Identify gender needs and interest
- Gender balanced extension system
- Mass media support
- Women friendly technologies
- Credit and technical support
- Capacity building of women
- Women farmer groups

ICAR-CIWA…in gender mainstreaming

- Farming system research
- Innovations in rural aquaculture
- Gender sensitive extension
- Technology assessment and refinement
- Occupational health risk and drudgery
- Family nutrition
- Women entrepreneurship
- Gender sensitization
- Gender sensitive methodologies and approaches
- Consultancy and advocacy

OCCUPATIONAL HEALTH HAZARDS

Agriculture Ranks as one of the most Hazardous Industry till today due to

- Seasonal nature of agricultural activities
- Traditional methods of work
- Mechanization
- Increasing use of pesticides and agro-chemicals
- Use of non-ergonomic tools and equipment
- Lack of education and information on the health hazards

Health problems of women as seen from a gender perspective

- Basically hazards posed by physical, chemical and biological agents in work place
- Similar for male and female workers
- Women on an average
    - ✓ have a smaller stature and have less physical strength
    - ✓ their vital capacity is 11% less
    - ✓ their hemoglobin is app. 20% less
    - ✓ their skin area is larger as compared to circulating volume
    - ✓ they have larger body fat content
- They have lower heat tolerance and greater cold tolerance.
- Reproductive function

Types of Occupational Hazards

- Mechanical hazards
- Psycho-social hazards
- Work organisation hazards
- Ergonomic hazards
- Others – Physical, Biological, chemical, ergonomical and psycho-social hazards

Health hazards of farm worker

Physical Hazards:

- Noise
- Vibration
- Extreme Temperature
- Illumination
- Radiation

Chemical Hazards:

- Renal Diseases
- Respiratory Diseases
- Skin Diseases

- ❖ Hematologic Diseases
- ❖ Cardiovascular Diseases
- ❖ Neurologic Diseases
- ❖ Carcinogenic
- ❖ Teratogenic

Other Harmful Effects of Noise:

- ❖ Hypertension
- ❖ Hyperacidity
- ❖ Palpitations
- ❖ Disturbs relaxation and sleep

Biological Hazards:

Agent / Disease	Occupation
Colds, influenza, scarlet fever, diphtheria, smallpox	May be contracted anywhere
Tuberculosis	Silica workers, people exposed to heat and organic dusts, and medical personnel
Anthrax	Animal handlers and handlers of carcasses, skins, hides, or hair of infected animals, including wool carpet processors and handlers.
Ringworm (in horses, cattle, deer, pigs, cats, dogs, birds)	Pet shop salesmen, stockmen, breeders of cats and dogs, and other animal handlers
Tetanus	Farmers (spores in soil) or anyone in contact with manure.

Hazard Control

- The first consideration for controlling hazards is to **eliminate** the hazard or **substitute** a less hazardous material or process.

- Engineering controls are physical changes to the work area or process that effectively minimize a worker's exposure to hazards
- If engineering controls are not feasible then consider implementing administrative controls.
- Examples of administrative controls include:
    a) Limited time exposure to hazards
    b) Written operating procedures
    c) Safety and health rules for employees
- When Engineering/ Administrative controls are not sufficient to protect from hazard and during emergencies, PPE is applicable.
- Use of apron, goggles, mask, shoe, helmet/cap etc

An occupational health program allows you to respond effectively to workplace injuries and illnesses and to monitor potential health problems.

AGRICULTURAL STATISTICS

Statistics is a mathematical science pertaining to the collection, tabulation, analysis, interpretation or explanation, and presentation of data. It is applicable to a wide variety of academic disciplines, from the physical and social sciences to the humanities.

Father of Statistics: Sir Ronald Aylmer Fisher (1890-1962)

- The **elements** are the entities on which data are collected.
- A **variable** is a characteristic of interest for the elements
- The set of measurements collected for a particular element is called an **observation**
- The total number of data values in a data set is thenumber of elements multiplied by the number of variables

Types of data:

- Qualitative Data
- Quantitative Data
  - ✓ Cross-sectional data are collected at the same or approximately the same point in time.
  - ✓ **Time series data** are collected over several timeperiods.

Mean

- The mean of a data set is the average of all the data values.
- The sample mean is the point estimator of the population mean *m*.

Median

- The median of a data set is the value in the middle when the data items are arranged in ascending order
- Whenever a data set has extreme values, the median
- It is the preferred measure of central location

POST-HARVEST TECHNOLOGIES IN FRUIT CROP

Maturity of Fruits and Vegetables

- It is the particular stage in life of plant of fruit at which they attain maximum growth and size
- There are five types of indices to judge the maturity of the fruit.

1. Visual means
2. Physical means
3. Chemical analysis
4. Computation
5. Physiological method

Controlled Atmospheric Storage

- In controlled atmospheric storage higher CO2 and lesser O2 are maintained
- The work on controlled atmosphere storage started in England in 1927 by kid and West. Modified atmosphere does not differ in principle from controlled atmosphere.
- In this the produce is held under the atmospheric condition by package, over wrap, box liner

Advantages of Controlled Atmosphere Storage:

i) Control all types of micro-organisms.
ii) Chilling injury and other physiological disorders.
iii) Black heart in potato

- Hypobaric or Sub-atmospheric System
- Waxing
- Polymeric Film
- Chemicals
- Irradiation

- Grading helps in obtaining uniform quality with respect to size, colour etc.
- It is done by hand or with the help of grading machines.

- Mechanical graders such as screen grader, roller graders, rope or cable graders are also used.
- Screen graders (made up of copper) are most commonly used.
- Soft and berry fruits are generally graded by hand picking
- Fruits like berries, plums, cherries and olives are graded whole while peaches, apricots, pears, mangoes are graded after cutting them into halves or slices.

DESIGN METHODOLOGY OF AGRICULTRAL MACHINERY

Following methodologies to be used in the design of agricultural machinery

- Farm mechanization
- Forces i.e. direction& Quantity
- Stress induced at the lower area & It should be reinforced
- Standard Components
- Properties of material
- Working principles
- Optimization of shape &size
- Ergonomics consideration
- Flow of material
- Power transmission
- Behaviour of soil & crop material
- Knowledge of environment parameters

ERGONOMICS

The term ERGONOMICS is derived from the Greek words; ergo: Work**;** nomos: Natural. It is the science dealing with MAN-MACHINE-ENVIRONMENT relationship to get the optimum output from it with less human cost.

Ergonomics in agriculture

- Agriculture has a marginal primitive image.
- Transformation of traditional agriculture to Mechanized agriculture is need of time.
- Ergonomic application is tangible, i.e., pertaining to cost-benefit ratio, intangible, human health, comfort and safety.

Anthropometry

- 'Anthropometry', the study of body dimensions and strength.
- To understand the principles of anthropometry, one must be conversant with the anatomical sites and bony prominence of the human body.
- The problems of work place and workspace are the most common anthropometric problems; and these problems fall under man-machine physical compatibility, that someone is too large or too small to fit the machine.
- By obviating these problems, often better equipment can be designed and a work place organized.

Biomechanics

- The skeleto-muscular structures determine the range, strength and speed of human movements, including response behaviour to physical forces such as acceleration and vibration.
- These information grouped under 'Biomechanics' are useful in avoiding injuries on the job, in tool design, in work place and task layout, and in the protection of personnel against mechanical forces.
- The range, strength and speed of body movements are analysed by various biomechanical techniques and the psycho-physical methodologies.
- When a muscle strength problem is identified, the information on strength characteristics of different muscles may help to assess the severity of the problem.
- Accordingly, the alternative solutions are obtained.

Energy consumption

- The type of work decides the stress on the human body.
- Frequent analysis is made with reference to energy delivery and the strain on cardio-vascular and respiratory system due to muscular work. physical efforts and demand of muscles, environmental factor, static muscular contraction,
- The endurance to work is, thus based on the adaptability of the cardio-respiratory system with concurrent development of the skeleto-muscular structures.
- This information is used in establishing work organization principles like work/recovery cycles, shift work or standard for an allowable load of day's work.
- Designing tools and jobs to conform to a permissible level of energy demand is an approach widely accepted for various applications.

POSTURAL ANALYSIS TECHNIQUES

- RULA : Rapid Upper Limb Assessment
- REBA : Rapid Entire Body Assessment
- OWAS : Ovako Working Posture Assessment system

RULA: Rapid Upper Limb Assessment

- Rapid upper limb assessment (RULA) is a survey method for use in ergonomics investigations of workplace where work-related upper limb disorders are reported.
- This tool requires no special equipment in providing a quick assessment of the posture of the neck, trunk and upper limbs along with muscle function and the external loads experienced by the body.
- RULA was developed to:

1. Provide a method of screening a working population quickly, for exposure to a likely risk of work-related upper limb disorders.

2. Identify the muscular effort which is associated with working posture, exerting force and performing static or repetitive work, and which may contribute to muscle fatigue.

REBA: Rapid Entire Body Assessment

Rapid Entire Body Assessment (REBA) is a postural analysis tool. It has been developed to fill a perceived need for a practitioner's field tool, specifically designed to be sensitive to the type of unpredictable working postures found in health care and other service industries.

The development of REBA aimed to:

- Develop a postural analysis system sensitive to musculoskeletal risks in a variety of tasks.
- Divide the body into segments to be coded individually, with reference to movement planes.
- Provide a scoring system for muscle activity caused by static, dynamic, rapid changing or unstable postures.

- Reflect that coupling is important in the handling of loads but may not always be via the hands.
- Give an action level with an indication of urgency.
- Require minimal equipment - pen and paper method.

OWAS: Ovako Working Posture Assessment system

Ovako working posture assessment system (OWAS) is used method for studying awkward working postures in workplaces. It identifies the most common work postures for the back (4 postures), arm (3 postures) and legs (7 postures) and the weight of the load handed (3 categories).

Fig.2-Ridger operation posture

RULA

Upper arm score	:	2+1=3
Lower arm score	:	1
Wrist score	:	2
Wrist twist score	:	2
Posture score (A)	:	**4**
Muscle use score	:	1
Force / load score	:	2

Wrist and arm score	***:***	***7***
Neck score	:	1
Trunk score	:	2
Leg score	:	2
Posture score (B)	:	**3**
Muscle use score	:	1
Force / load score	:	2
Neck, trunk and leg score	***:***	***6***
Final score	:	***7***
Inference	:	Investigate and implement change

REBA

Neck score	:	1
Trunk score	:	2
Leg score	:	2+1=3
Posture score (A)	**:**	**4**
Score A	**:**	**5**
Upper arm score	:	2+1=3
Lower arm score	:	1
Wrist score	:	1
Posture score (B)	**:**	**3**
Coupling score	:	1
Score B	**:**	**4**
Table C	***:***	***5***
Activity	:	1
Final Score	***:***	***6***
Inference	***:***	*Medium Risk ,Further investigate &Change soon*

Fig.3-Wheel hoe operation posture

RULA

Upper arm score	:	1+1=2
Lower arm score	:	1
Wrist score	:	2+1=3
Wrist twist score	:	1
Posture score (A)	:	**3**
Muscle use score	:	1
Force / load score	:	2
Wrist and arm score	***:***	***6***
Neck score	:	2
Trunk score	:	2
Leg score	:	2
Posture score (B)	:	**3**
Muscle use score	:	1
Force / load score	:	2
Neck, trunk and leg score	***:***	***5***
Final score	:	***6***
Inference	:	Further Investigate and change soon

REBA

Neck score	:	1
Trunk score	:	2
Leg score	:	2+1=3
Posture score (A)	**:**	**4**
Force / load score	:	1
Score A	**:**	**5**
Upper arm score	:	1+1=2
Lower arm score	:	1
Wrist score	:	1+1=2
Posture score (B)	**:**	**2**
Coupling score	:	2
Score B	**:**	**4**
Table C	***:***	***6***
Activity	:	1
Final Score	***:***	***7***
Inference	***:***	*High Risk ,Further investigate &Change soon*

HUMAN ENERGY CONSUMPTION

- Human body is an engine.
- Food is metabolized to give energy to do mechanical work
- Energy expenditure of a person can be calculated by measuring the amount of oxygen intake.
- Calorific value of oxygen is 20.88 kJ/ l of O_2
- Maximal oxygen uptake capacity or VO_2 max is defined as the capacity of an individual to consume maximum amount of oxygen from the outer atmosphere.
- Women have 70 to 75 % of that of men.
- Indian agricultural workers :
- Female : 1.6 l/min
- Male : 2.2 l/mi
- Physiological cost of any operation is expressed in terms of heart rate and oxygen consumption rate.
- AWL: Acceptable work load, 35-40% of VO_2 max i.e. 0.6 & 0.8 l/min for female and male.
- Approximately the heart rate corresponding for this will be 110 to 120 bpm
- For most individuals HR of 120-130 bpm is 50 % of Vo_2 max. Here the person starts getting out of breath.
- Limit of continuous performance for 8-hour day (LCP) is suggested as 40-work pulse per minute
- In favourable conditions the work efficiency of the human body can be 25 – 30 %. But for field activities it ranges from 3 -25 %.
- Computerized ambulatory metabolic measurement system (K4b2)
- **Maximum heart rate = 190 - (Age in years – 25) x 0.62**

  Estimation of oxygen consumption rate and energy consumption

  - Male workers:
    - Y = 0.0183 HR – 1.28 *(Nag, 1981, agri workers)*
    - Y = 0.0156 Hr – 0.88 *(Tiwari et al , 2010, agri workers)*
    - Y = 0.014 HR – 0.8 *(ESA, agri workers)*
  - Female workers :
    - Y = (0.159 HR -8.72) / 20.9 *(Verghese et al, 1994, college students)*
    - Y = 0.0114 HR – 0.68 *(Singh et al 2008, farm women)*
    - Y = 0.011HR – 0.59 *(ESA, agri workers)*

ANTHROPOMETRIC DATA FOR 79 BODY DIMENSION OF CENTURION TRAINEES

Dimension	Ardhendu	Dibya	Mohan	Ranjan	Shubham
Weight, kg	72	56	70	66	68
Stature, mm	1650	1690	1630	1710	1720
Vertical reach, mm	2030	1860	2120	2230	2220
Vertical grip reach, mm	1922	1800	1980	2120	2110
Eye height, mm	1500	1580	1530	1630	1620
Acromial height, mm	1335	1430	1360	1410	1420
Elbow height, mm	1050	1000	1030	1120	880
Olecranon height, mm	1032	1010	980	1050	1040
Iliocrystale height, mm	930	920	920	1000	1030
Iliospinal height, mm	900	895	910	990	1010
Trachenteric height, mm	785	850	800	940	950
Metacarpa height, mm	720	750	690	740	730
Knee height, mm	470	480	450	520	510
Medial Mallealus height, mm	60	85	70	65	80
LateriaMallealus height, mm	55	90	80	80	90
Menton to top of the head, mm	200	200	210	220	230
Waist back length, mm	480	520	520	540	550
Elbow rest height, mm	230	270	230	240	250
Span, mm	1620	1680	1710	1770	1850
Span akimbo, mm	870	860	900	900	940
Arm reach from the wall, mm	750	850	790	850	810
Thumb tip reach, mm	670	730	710	770	750
Shoulder grip length, mm	630	680	690	750	730
Wall to acromion distance, mm	110	110	125	117	95

Wall to lumbosacral joint distance , mm	45	50	35	60	50
Abdominal extension to wall, mm	255	220	260	230	235
Chest depth, mm	210	220	270	215	215
Biacromial breadth, mm	280	320	300	330	310
Bideltoid breadth, mm	440	410	430	460	440
Chest breadth, mm	300	280	300	270	260
Inter scye breadth, mm	310	320	340	325	310
Waist breadth, mm	320	290	300	280	310
Hips breadth, mm	340	300	380	310	360
Heel breadth, mm	50	70	75	64	69
Bimalleolar breadth, mm	70	75	70	70	72
Chest circumference , mm	920	840	940	900	900
Waist circumference, mm	300	290	320	280	310
Thigh circumference, mm	500	430	520	525	450
Calf circumference, mm	370	310	360	340	350
Wrist circumference, mm	160	150	160	165	170
Grip diameter (inside) , mm	40	45	40	50	45
Grip diameter (outside) , mm	80	80	75	85	80
Middle finger-palm grip diameter, mm	30	30	30	40	35
Vertical grip sitting, mm	1060	1380	1340	1280	1250
Setting height, mm	870	910	880	885	920
Sitting eye height, mm	710	800	760	770	795
Sitting acromion height, mm	560	630	600	620	610
Elbow rest height, mm	230	270	230	240	250
Thigh clearance height sitting, mm	160	130	160	130	130
Knee height sitting, mm	520	510	520	550	550

Popliteal height sitting, mm	440	460	440	500	480
Hand thickness at metacarpal –III, mm	33	29	28	32	30
First phalanx digit III length, mm	63	67	62	66	67
Grip length, mm	65	60	57	65	58
Maximum grip length, mm	110	118	117	113	125
Index finger diameter, mm	17	18	19	21	19
Head length, mm	180	185	180	190	195
Head breath, mm	150	125	130	120	130
Coronoid fossa to head length, mm	355	420	350	415	457
Fore arm head length, mm	415	457	450	470	495
Elbow grip length, mm	320	340	350	360	395
Hand length, mm	180	185	175	185	190
Palm length, mm	95	105	90	100	98
Hand breadth across Thumb, mm	96	95	100	113	102
Hand breadth, mm	82	87	85	90	85
Buttock knee length, mm	565	550	530	560	550
Buttock popliteal length, mm	445	455	470	465	460
Abdominal depth sitting, mm	240	170	240	210	210
Hip breadth sitting, mm	350	340	390	340	350
Elbow Elbow breadth sitting, mm	385	330	450	360	350
Knee Knee breadth, mm	235	190	220	180	185
Foot length, mm	238	245	250	255	255
Instep length, mm	193	190	200	200	200
Foot breadth, mm	97	105	95	110	110
Functional leg length, mm	938	960	950	1250	1300
Bicep skinfold thickness,	15	4	8	5	9

mm					
Tricep skin fold Thickness, mm	8	5	10	6	5
Sub scapular skin fold Thick ness, mm	13	12	16	17	13
Supra Iiac skinfold Thickness, mm	26	8	33	10	20

PROJECT

DESIGN AND DEVELOPEMENT OF GENDER FRIENDLY PORTABLE SHED FOR OPERATION IN DIFFERENT CROPS

1. INTRODUCTION

Horticultural crops like chilly has been planted and harvested in the month of March-April and October -November. In the chilly growing belt of Odisha the average temperature ranges from 38 to 40ºCrelative humidity from 60 - 70 % and wind velocity 17 to 18 Km/hr. Most of the harvesting occurs during this time. Due to the adverse environmental parameters the farm workers are getting badly affected. They can't work continuously in the field and various health hazard may occur. To mitigate these problems it is proposed to use "PORTABLE SHED" during the period of intercultural operation, harvesting, planting in the time of summer as well as rain.

It is protecting structure which to be used during agricultural field operations like weeding harvesting etc. to prevent farm women form scorching sun rays which leads to extreme light intensity & increased the ambient temperature to create intolerable and uncomfortable working condition. It also helps us during the rainy season to continue the farm work even in heavy rain.

Objective:

1. Study and selection of different covering material with perspective of environmental parameters.
2. Design of the gender friendly shading structure considering anthropometric parameters of Indian agriculture workers.
3. Performance evaluation of fabricated shading structure.

2. Review of Literature

The climate of India comprises a wide range of weather conditions across a vast geographic scale and varied topography. The nation has four seasons: winter (December, January and February), summer (March, April and May), a monsoon rainy season (June to September), and a post-monsoon period (October to November). The hottest of all seasons, summer extends in Rajasthan from April to June. During summers, the temperature in Odisha is very high and it ranges somewhere between 32º C and 48ºC. The place has an average temperature of 38º C. At Bhubaneswar maximum temperature in April varies from 34.5 to 41.4°C, in May it varies from 35 to 43.2°C and in June it varies from 41.9 to 45.9°C. During these times WBT outdoor varies from 28°C to 32°C, which is the indication of heat stress.

Heat stress may be defined as the combination of all those factors both climatic and non-climatic which lead to convective or radiant heat gained by the body or prevent heat dissipation from body. Heat stress occurs when the body's means of controlling its internal temperature starts to fail. As well as air temperature, factors such as work rate, humidity and clothing worn while working may lead to heat stress. Therefore, either it may not be obvious to someone passing through the workplace that there is a risk of heat stress or there should be taken some protective measures for protection against heat stress. Increased heart rate, increased body-core temperature and sweating are the physiological responses to heat stress (Huguette and Pierre, 2009). A significant drop in mental performance is observed at temperatures above 32.2° (Basic Effective Temperature) in a hot-humid environment and 33° in a hot-dry environment.

Most of the agricultural operations in the country are still being performed by human whether as manual labour or as operator. Ploughing, sowing, intercultural operations and harvesting are the main agricultural operations which are being performed in hot sunny days and some of them are performed by manual tools. Women play a significant and crucial role in agricultural development and allied fields including in the main crop production, livestock production, horticulture, post-harvest operations, agro social forestry, fisheries, etc. Agriculture sector employs 4/5th of all economically active women in the country. 48percent of India's self-employed farmers are women. When female farm workers are working under open sun or in hot environment there are chances of heat stress like stroke, exhaustion, cramps, collapse, rashes, fatigue or skin problem. The excess body temperature should dissipate to environment by the conduction, convection, radiation and evaporative cooling or sweat cooling. Most adverse effects arise from a failure of the body's cooling mechanisms. In heat stress condition the body temperature may rise and receptors sensitive to change in temperature in the skin, muscle, stomach and other areas of the central nervous system. Therefore, the study was undertaken to investigate methods to reduce performance of female farm workers for agriculture operation.

High humidity can have an adverse effect on the human body. Because the air feels warmer than the official, recorded temperature, it can contribute to feelings of low energy and lethargy. In addition, hyperthermia or over-heating as a result of your body's inability to effectively let out heat, can negatively impact your health in conditions of high humidity. Some health risks which result from overexposure to humidity (hyperthermia) include:

- Dehydration
- Fatigue
- Muscle cramps
- Heat exhaustion
- Fainting
- Heat stroke

3. Material& Methods

To design a protective structure for the female field workers, appropriate shading material had to be selected. Market survey was done to assessavailable array of materials. Material enclosed below were selected and their performance was evaluated with respect to three environmental parameters viz. light intensity (lux), relativehumidity (%)& temperature (^{o} C).

3.1 Materials

i. Polyester

Polyesters are polymers in which the backbones are formed by the "esterification condensation of polyfunctional alcohols and acids"

- Polyester fabrics and fibres are extremely strong.
- Polyester is very durable: resistant to most chemicals, stretching and shrinking, wrinkle resistant, mildew and abrasion resistant.
- Polyester is hydrophobic in nature and quick drying. It can be used for insulation by manufacturing hollow fibres.
- Polyester retains its shape and hence is good for making outdoor clothing for harsh climates.
- It is easily washed and dried

ii. Synthetic rubber

Synthetic leather fabrics imitate the natural product with a densely entangled fibre construction that is impregnated with a polyurethane resin to give a smooth surface free from needle marking and with a high surface abrasion resistance

iii. Synthetic Leather

A synthetic rubber is any artificial elastomer. These are mainly polymers synthesized from petroleum by products.

iv. Canvas(White& dyed green)

Canvas is an extremely durable plain-woven fabric used for making sails, tents, marquees, backpacks, and other items for which sturdiness is required. It is also popularly used by artists as a painting surface, typically stretched across a wooden frame. It is also used in such fashion objects as handbags, electronic device cases, and shoes. The canvas is also available in variety colours like green.

Synthetic leather

Synthetic rubber

Polyester

Canvas- white

Canvas- Green

Fig.1: Different covering materials used in the experiment

The above mentioned five materials are durable in adverse environmental condition like high temperature and humidity. It is also water resistance up to some extent. The same are shown in fig.1.

3.2. Methods

3.2 .1.Design of experiment for selection of material

Five frames of 30*30*50 cm were fabricated to conduct the experiment.

Pieces of materials were positioned on the frame and these were placed in field where sun light fell naturally. The temperature, humidity & light intensity difference under the material & ambient was recorded. The arrangement is shown in the figure below.

Fig. 2: Arrangement of different materials under natural conditions to record light intensity, temperature & relative humidity

3.2.2. Design of frame

The design of the structure was done after considering the agronomical parameters of the crops and the anthropometric parameters of Indian farm labours. The details of design and fabrication are elaborated further.

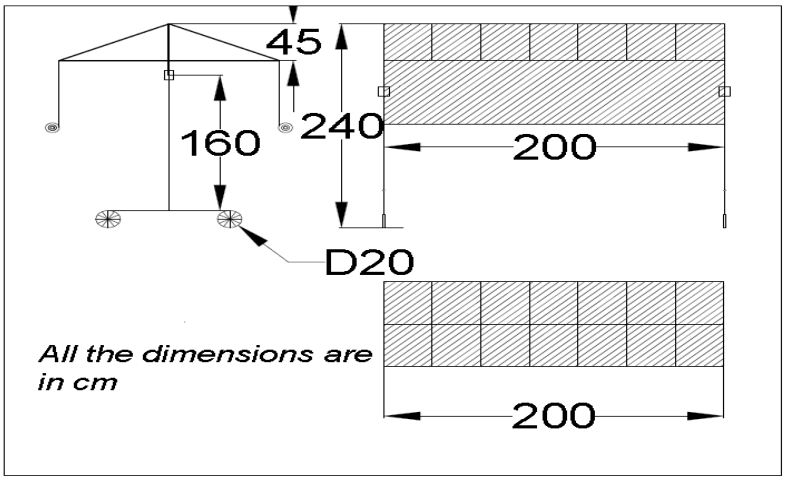

Fig. 3a. Schematic diagram of the frame

Distance between two legs:

Row to row distance between chilly is 25 inches=63.5cm.Considering that the structure will cover three plants row wise at a time i.e. 63.5cm*3=190.5cm

Additional 5cm on each side for easy wheel placement hence 190+10=200cm

Total length of shed=200cm

Height of shed:

Average height of male Indian agriculture labour=175.6cm (95 percentile was chosen for keeping the structure gender friendly)

Height of shed endpoint to base =180cm

Width of shed:

The majority of agricultural operations like weeding, harvesting etc. are done in squatting or bending posture. Hence, the reach of male Indian labour in squatting posture was observed to be in the range of 75-80 cm. It was decided that to pair of labour facing opposite side would work in the shed hence 80*2=160cm and over head of 20cm =160+20=180cm

Roof angle of the shed=120^0

Total Height of shed=180+45+15=240cm (15cm given for better adjustment)

Diameter of wheel=20cm (For portability)

Particulars	Length (cm)
Total Height of shed	240
Total Length of shed	200
Height of lowest point of shed to base	180
Width of shed	180
Diameter of wheel	20

Fig. 3b: Skeleton Frame of shedding

3.2.3. Mobility Test

Objective:

To test the mobility and distinguish the result between concrete and undulated land surface.

Materials Required:

1. Measuring Tape (100 m)
2. Chalk Piece
3. Calculator

Procedure:

1. Test on concrete:
    - A line was marked on concrete surface as reference starting point.
    - The equipment was aligned with reference line.
    - Wheel was marked at certain point to count the revolutions.
    - The equipment was pushed by two persons at extreme ends.
    - Simultaneously during movement of equipment number of revolutions (30) of wheel was counted.
    - At exactly 30 rotations the equipment was stopped and Final line was marked.

- With the use of measuring tape, the distance between final and reference line was measured.

The same process was repeated on the undulated soil surface.

3.2.4: Performance evaluation of shading structure.

The white canvas covering was stitched along the required dimension and fixed on the frame. Observation for relative humidity, light intensity & temperature were recorded and compared with ambient condition.

Fig 3c: Stitching of covering material

Fig 3d: Evaluation of Performance

4. RESULT and DISSCUSSION

The experiment was performed as explained on the material and method chapter. Here the results of the same are presented and discussed.

4.1 Selection of material

The results of the experiment for selection of material were carried out as explained in 3.2.1. The temperature, humidity& light intensity were recorded using a commercially available thermo-hygrometer, for three days for better understanding of the effect of various materials on the selected environmental parameters. The results are presented day wise.

Day 1:

The observations are tabulated below:

A. TABLE-1: Environmental Parameter readings of Day 1

30-08-2018		CA. GREEN	CA.WHITE	SYN.LEATHER`	SYN.RUBBER	POLYSTER	AMBIENT
TIME	EV.PARAMETER						
11.3	L.I(LUX)	500	1100	340	250	100	45000
	R.H(%)	67	64	64	64	63	77
	T(Deg. C)	34.3	34,3	34.4	34.6	35	37
12	L.I(LUX)	1500	3200	720	610	85	74000
	R.H(%)	59	59	58	59	50	57
	T(Deg. C)	35.6	35.4	36.3	36.2	36.8	37
12.3	L.I(LUX)	700	1120	700	630	91	35000
	R.H(%)	52	53	53	53	52	53
	T(Deg. C)	36.1	35.9	36.4	36.7	37.3	38.2
13	L.I(LUX)	750	1100	780	650	85	40000
	R.H(%)	50	51	52	51	51	51
	T(Deg. C)	37.3	36	37.2	37.3	37.4	38
13.3	L.I(LUX)	1400	2800	710	580	88	44500
	R.H(%)	50	50	50	50	51	50
	T(Deg. C)	36.6	36.2	36.8	37.2	37.7	38.4

The relationship of the light intensity with the various materials and ambient condition throughout the day is represented in fig 4 & 5. It can be observed that the white canvas has the maximum light intensity as compared to other materials.

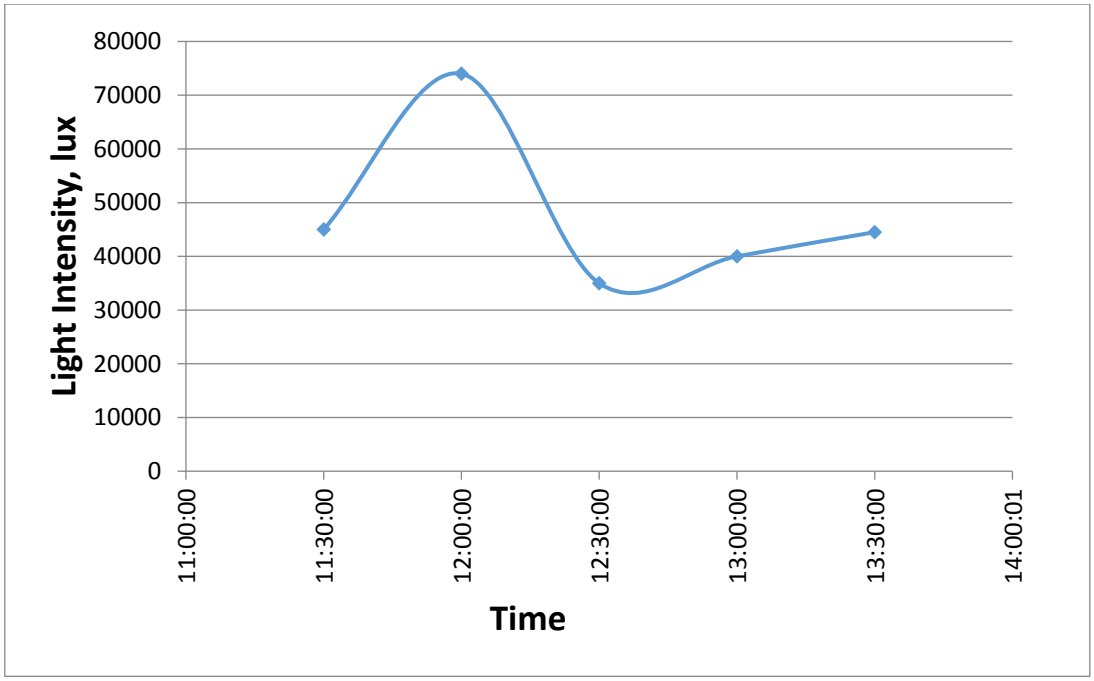

Fig 4: Light Intensity vs Time (Day 1); AMBIENT

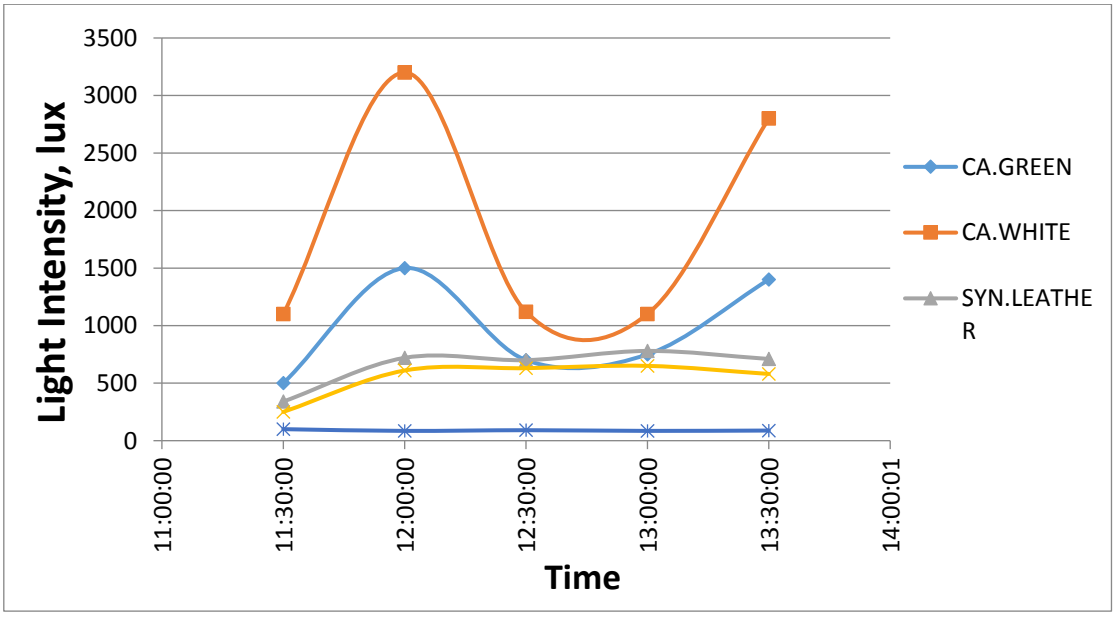

Fig 5: Light Intensity vs Time (Day 1); Materials

The relationship of the relative humidity with the various materials and ambient condition throughout the day is represented in fig 6 & 7. It can be observed that the materials do not affect the relative humidity significantly.

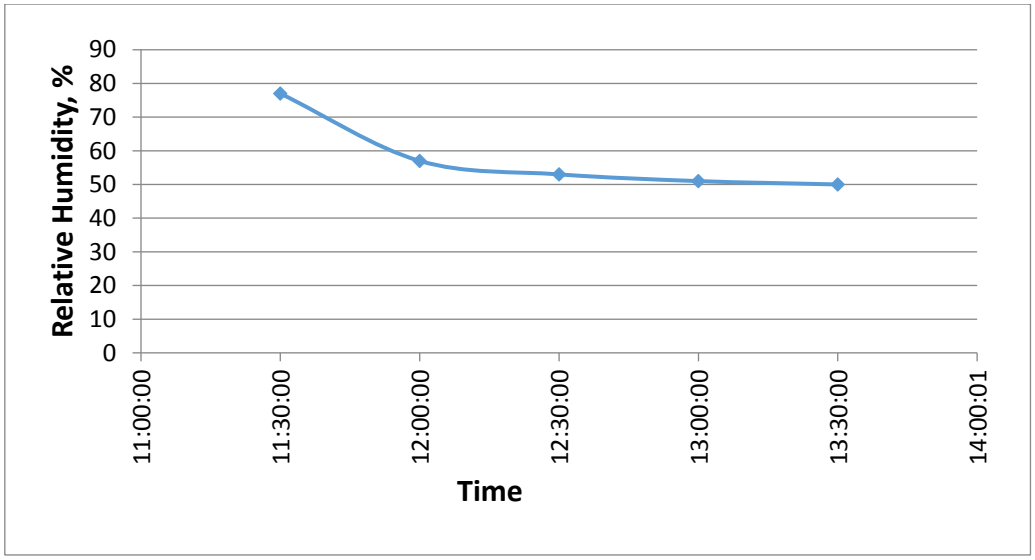

Fig 6: Relative Humidity vs time (Day 1); Ambient

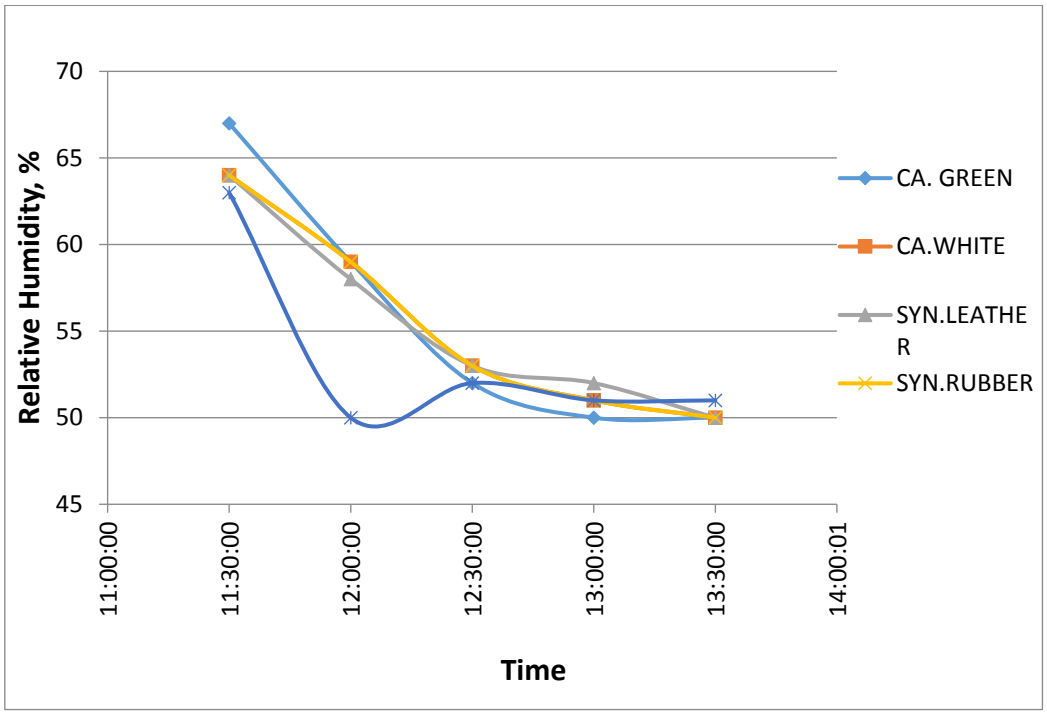

Fig7: Relative intensity vs time (Day1); Materials

The relationship of the Temperature with the various materials and ambient condition throughout the day is represented in fig 8 & 9. It can be observed that the white canvas has the minimum temperature as compared to other materials.

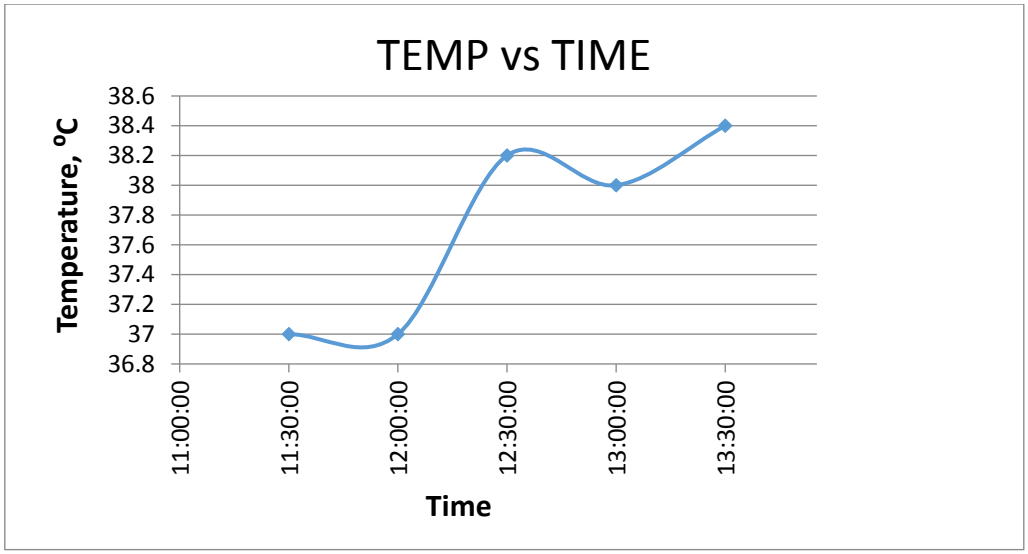

Fig 8: Temperature vs time (Day 1); Ambient

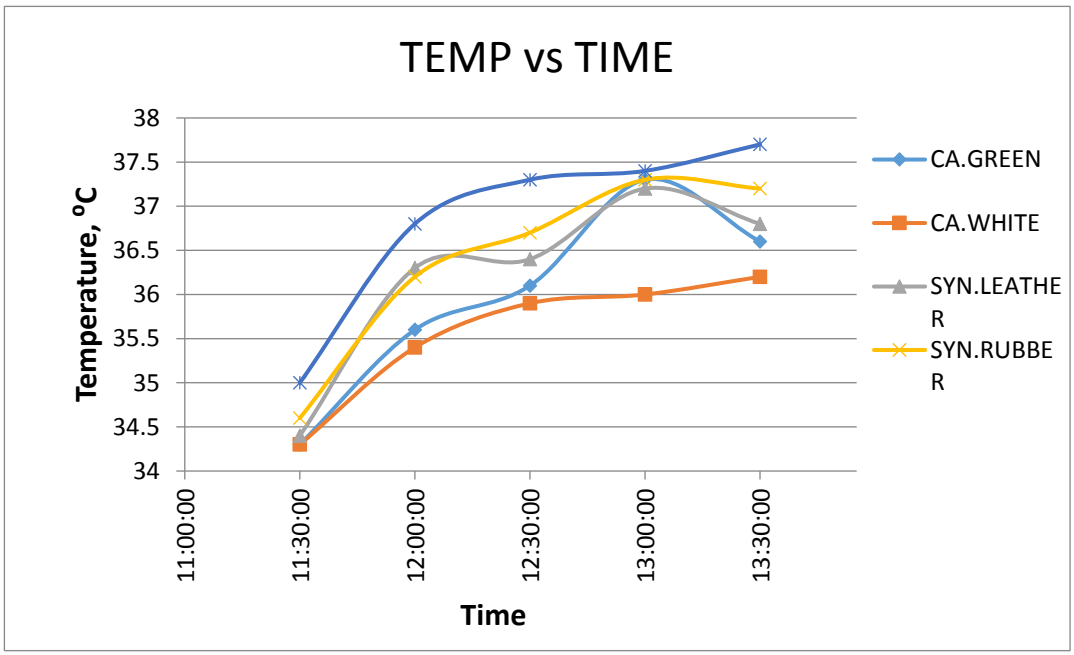

Fig 9: Temperature vs time (Day 1); Materials

Day 2:

The observations are tabulated below:

B. TABLE-2: Environmental Parameter readings of Day 2

31-08-2018		CA. GREEN	CA.WHITE	SYN.LEATHER`	SYN.RUBBER	POLYSTER	AMBIENT
TIME	EV.PARAMETER						
10	L.I(LUX)	2360	2060	172	188	128	46200
	R.H(%)	50	53	54	56	57	51
	T(Deg. C)	39.7	37.4	37.6	37.7	37.8	38.1
10.3	L.I(LUX)	3540	2720	690	550	450	42700
	R.H(%)	42	47	47	47	50	43
	T(Deg. C)	40	39.1	39.2	39	38.9	41.5
11	L.I(LUX)	1500	2480	486	308	134	55000
	R.H(%)	38	40	40	38	39	34
	T(Deg. C)	43.1	42	42.4	43	43.3	44.8
11.3	L.I(LUX)	1920	3460	384	296	143	46200
	R.H(%)	34	36	32	34	35	36
	T(Deg. C)	40.9	40.2	41.3	41.5	41.7	42.5
12	L.I(LUX)	1460	1600	400	340	152	55000
	R.H(%)	50	48	45	44	46	46
	T(Deg. C)	37.9	37.4	38.2	38.7	39	38.9
12.3	L.I(LUX)	950	1360	300	230	255	35000
	R.H(%)	50	49	48	47	47	48
	T(Deg. C)	37.6	36.6	39.1	38.4	38	39.8
13	L.I(LUX)	1010	1320	380	280	262	34600
	R.H(%)	42	43	42	45	43	45
	T(Deg. C)	39.8	39.4	40.1	40.4	40.6	40.7
13.3	L.I(LUX)	370	142	125	85	37	10500
	R.H(%)	54	53	54	53	50	54
	T(Deg. C)	36.2	36.4	36.8	37.1	37.2	37.5
14	L.I(LUX)	350	430	141	96	30	30000
	R.H(%)	46	44	48	46	50	52
	T(Deg. C)	35.9	36	36.4	36	36.1	36.4
14.3	L.I(LUX)	250	277	138	102	45	8500
	R.H(%)	74	70	74	73	75	75
	T(Deg. C)	30.5	30.5	30.7	30.6	31	31

The results of day 2 are in concurrence with day 1

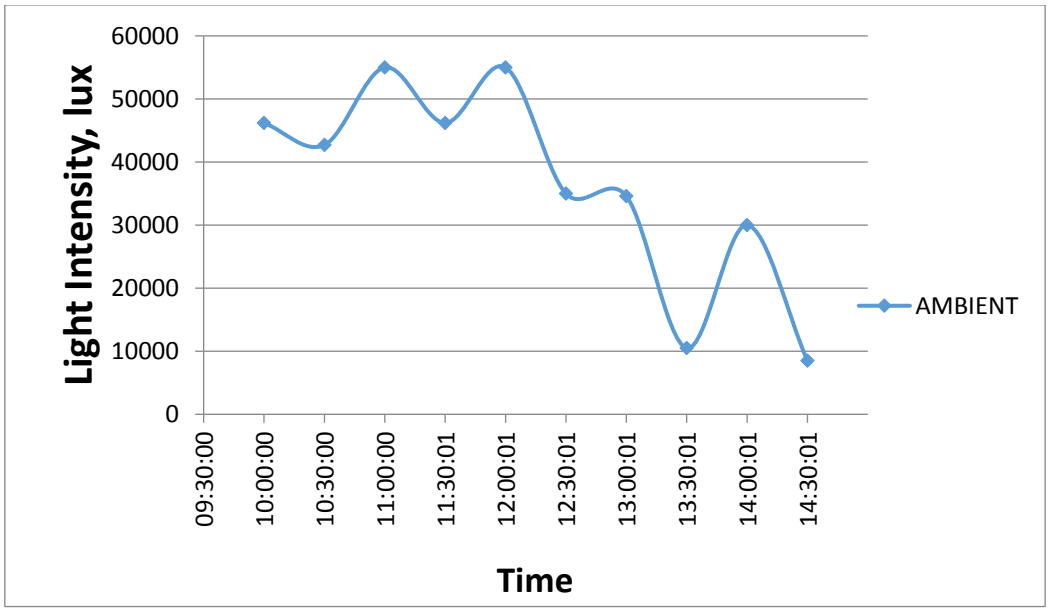

Fig-10: Light Intensity vs Time (Day 2); Ambient

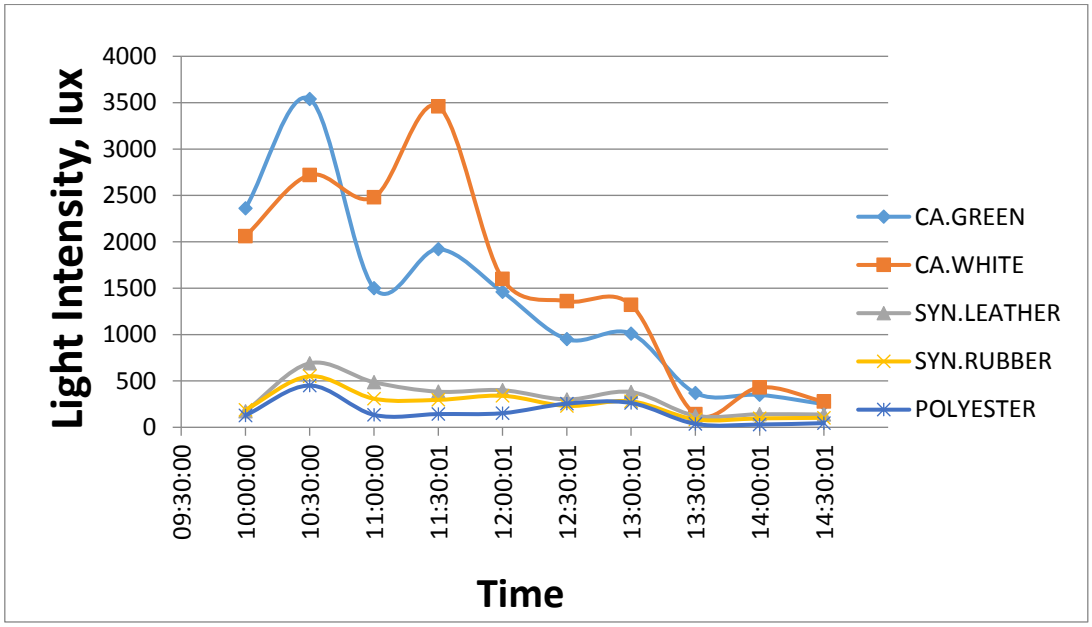

Fig-11: Light Intensity vs Time (Day 2); Materials

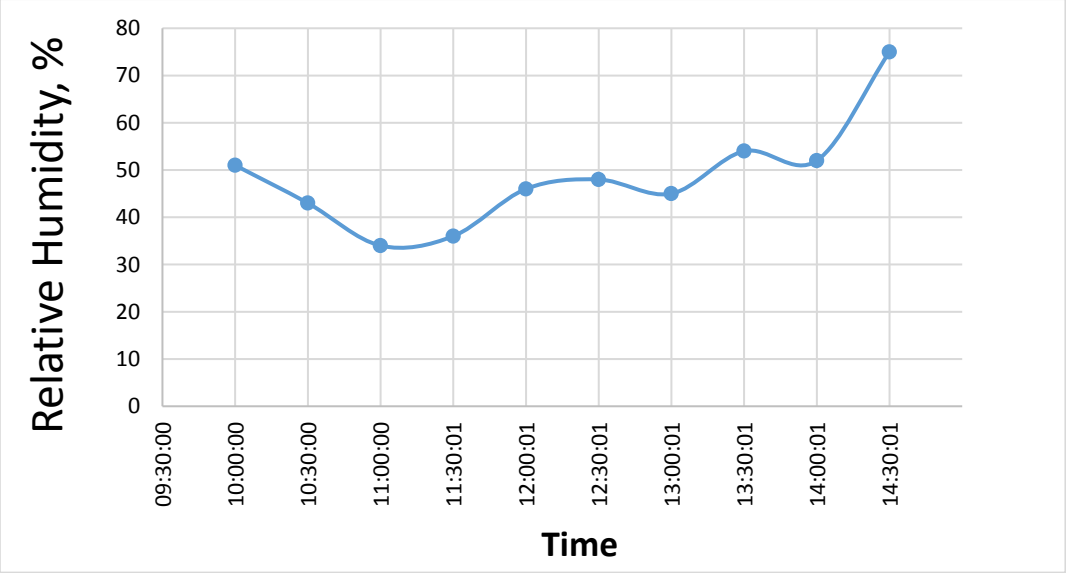

Fig 12: Relative Humidity vs time (Day 2); Ambient

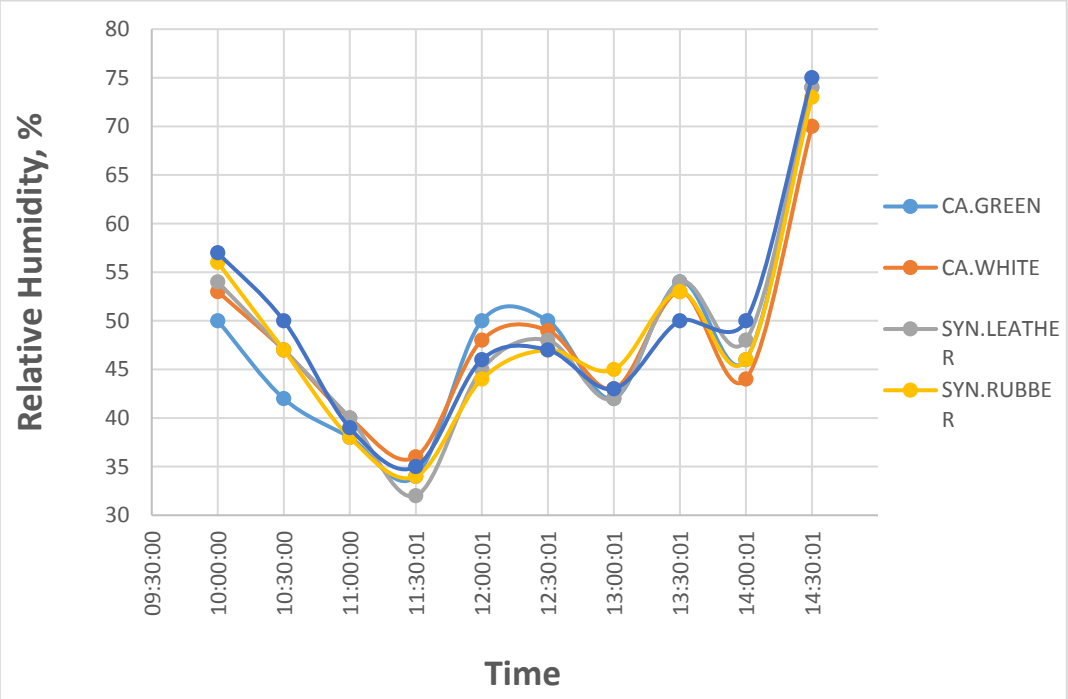

Fig 13: Relative Humidity vs time (Day 2); Material

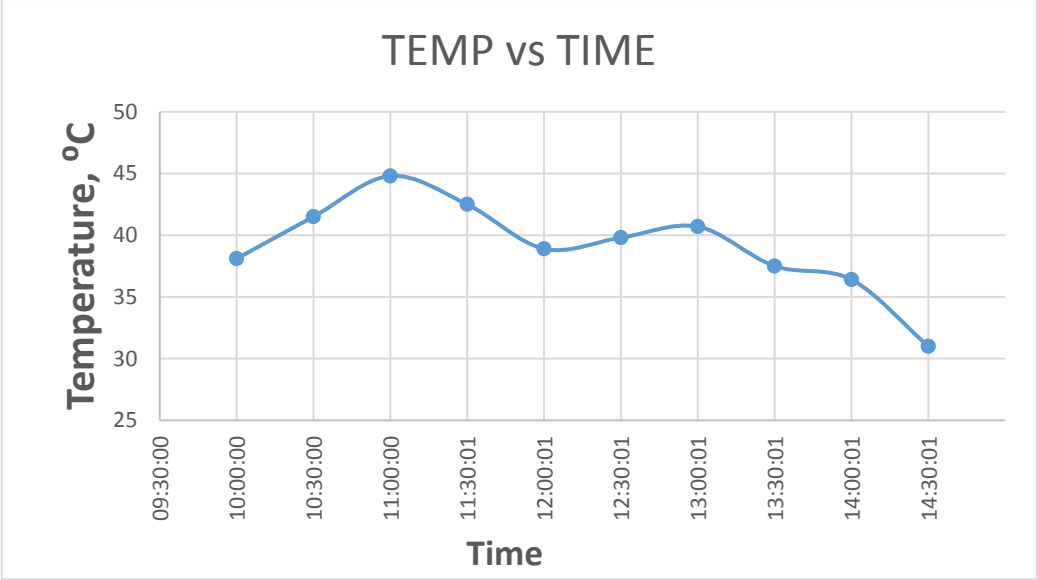

Fig 14: Temperature vs time (Day 2); Ambient

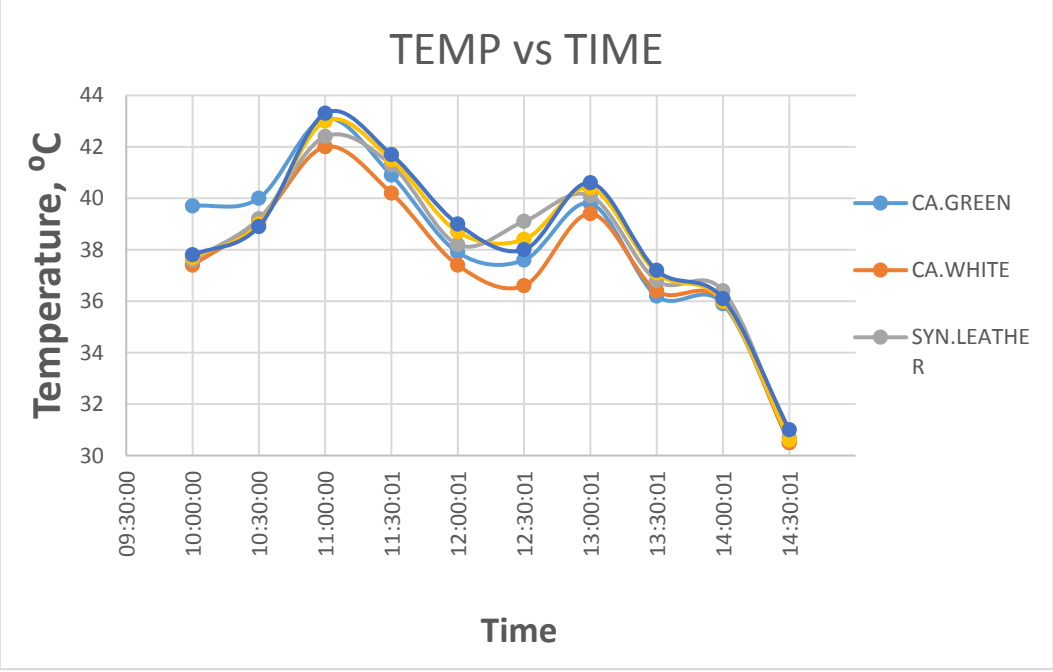

Fig 15: Temperature vs time (Day 2); Materials

Day 3:

The observations are tabulated below:

C. TABLE-3: Environmental Parameter readings of Day 3

01-09-2018		CA. GREEN	CA.WHITE	SYN.LEATHER`	SYN.RUBBER	POLYSTER	AMBIENT
TIME	EV.PARAMETER						
10.3	L.I(LUX)	2100	1900	550	448	106	59500
	R.H(%)	61	62	60	62	63	64
	T(Deg. C)	34.6	34.1	35.2	34.9	35.3	35.4
11	L.I(LUX)	2560	2400	482	367	95	64100
	R.H(%)	63	64	61	64	60	61
	T(Deg. C)	34.2	34	34.5	34.6	34.8	35.1
11.3	L.I(LUX)	2040	3700	850	764	108	98600
	R.H(%)	71	70	72	74	72	70
	T(Deg. C)	37.2	36.9	37.7	37.9	38.2	38.4
12	L.I(LUX)	1040	2280	576	494	126	49600
	R.H(%)	56	58	60	57	58	60
	T(Deg. C)	34.1	33.9	34.2	34.2	34.4	34.6
12.3	L.I(LUX)	940	1930	614	463	146	46800
	R.H(%)	53	52	50	52	54	54
	T(Deg. C)	37.2	37.1	37.2	37.3	37.3	37.4
13	L.I(LUX)	1060	2080	553	436	108	56300
	R.H(%)	54	53	54	50	52	54
	T(Deg. C)	37	37.1	37.1	37.2	37.2	37.5
13.3	L.I(LUX)	640	1100	378	346	157	43000
	R.H(%)	44	42	44	43	44	44
	T(Deg. C)	37.6	37.5	37.8	38.1	38	38.4
14	L.I(LUX)	640	1240	328	288	86	38000
	R.H(%)	44	42	43	44	43	44
	T(Deg. C)	39.5	39	40.1	40.3	40.4	40.5

The result of day 3 is in concurrence with day 1

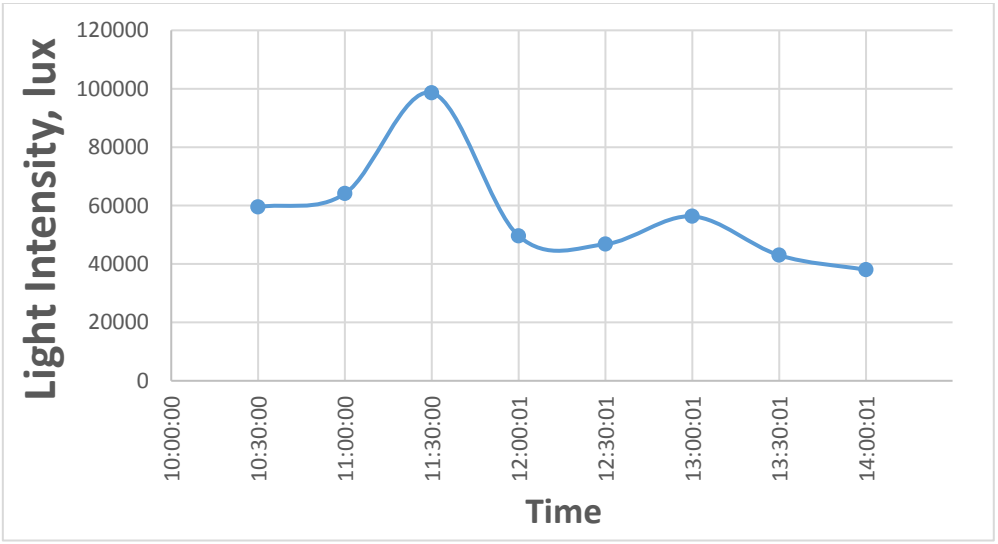

Fig-16: Light Intensity vs Time (Day 3); Ambient

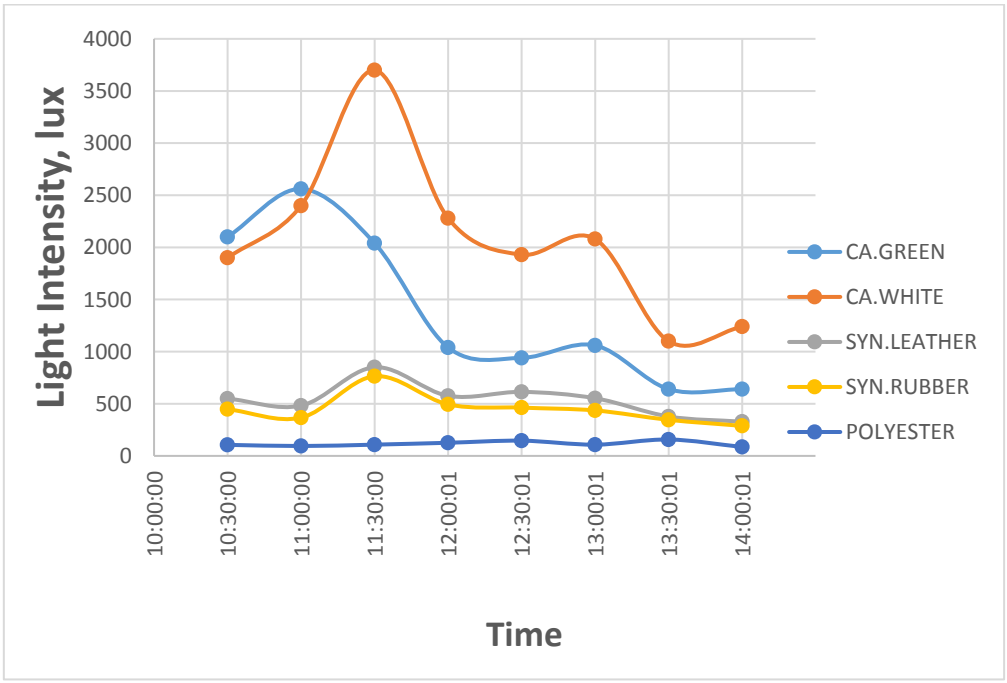

Fig-17: Light Intensity vs Time (Day 3); Materials

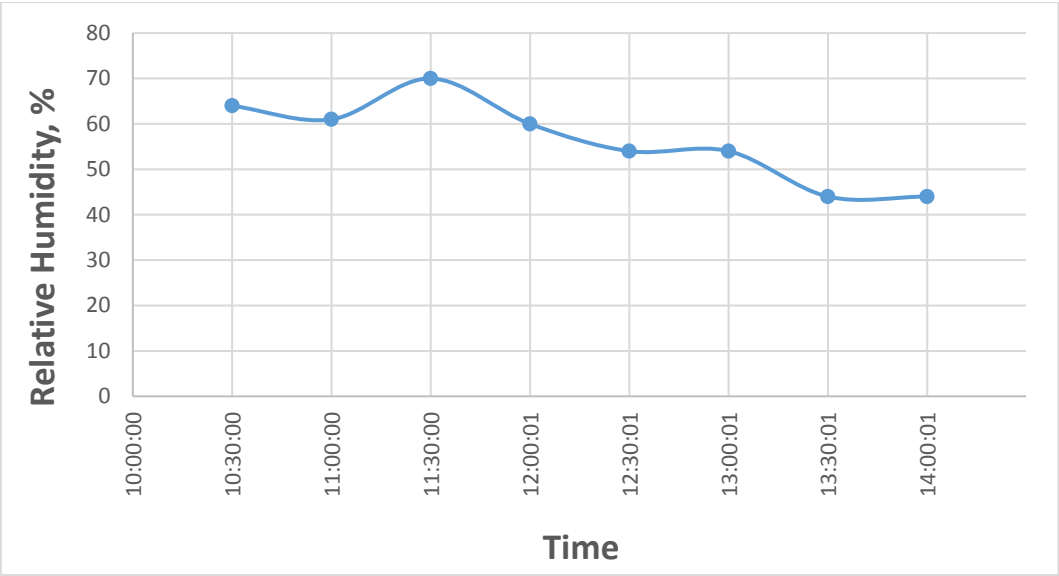

Fig 18: Relative Humidity vs time (Day 3); Ambient

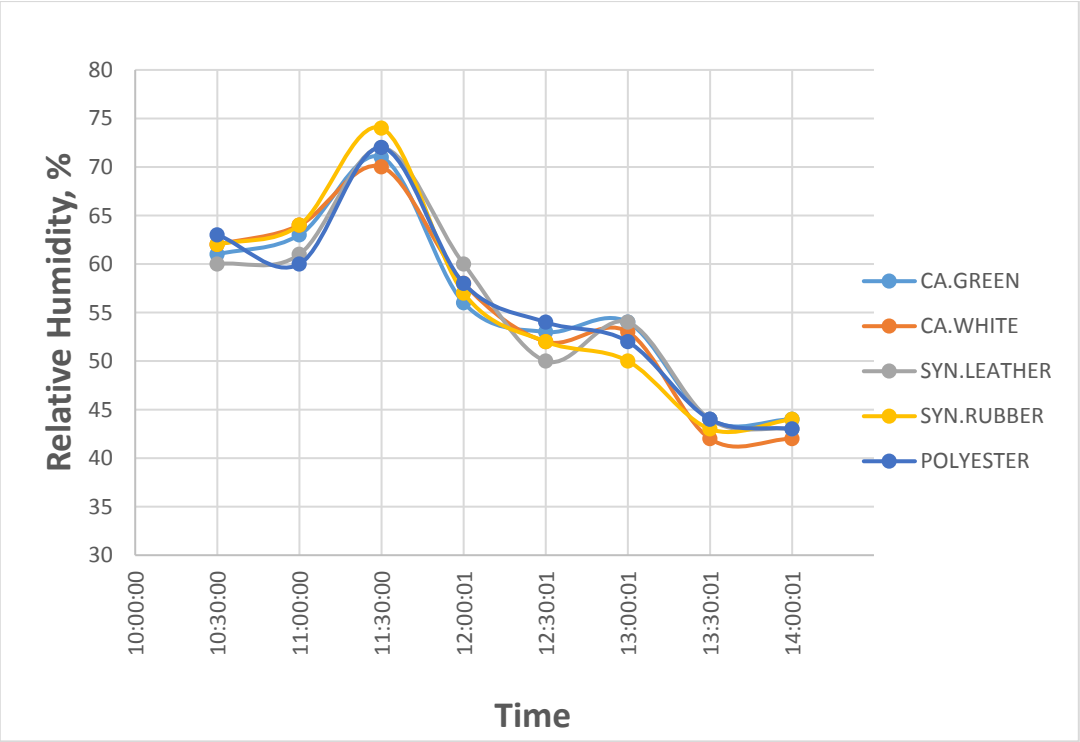

Fig 19: Relative Humidity vs time (Day 3); Materials

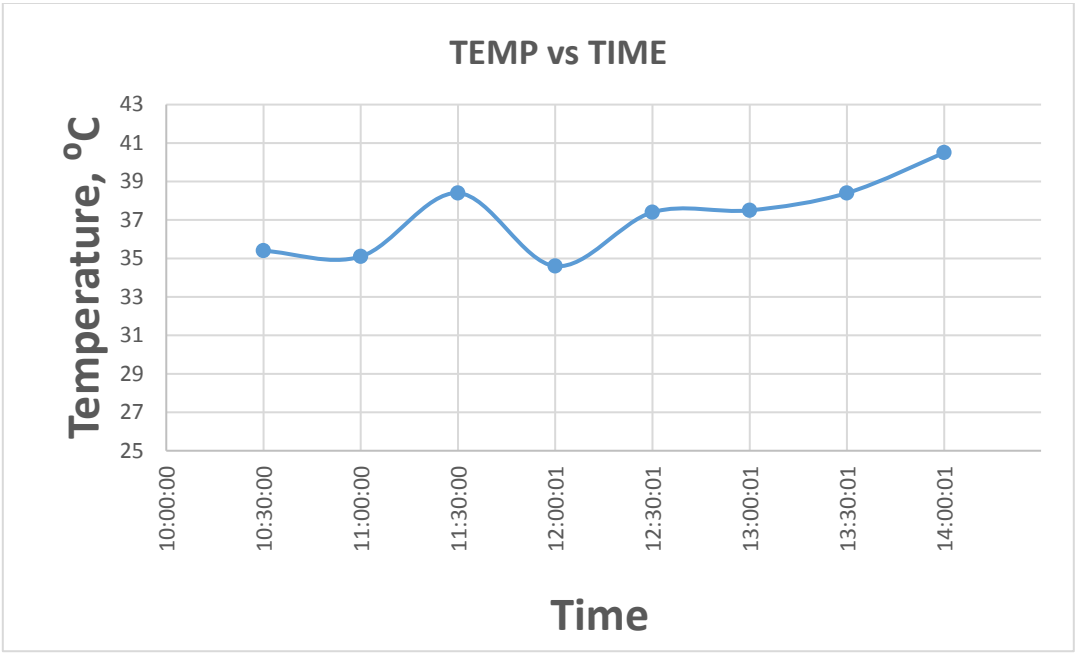

Fig 20: Temperature vs time (Day 3); Ambient

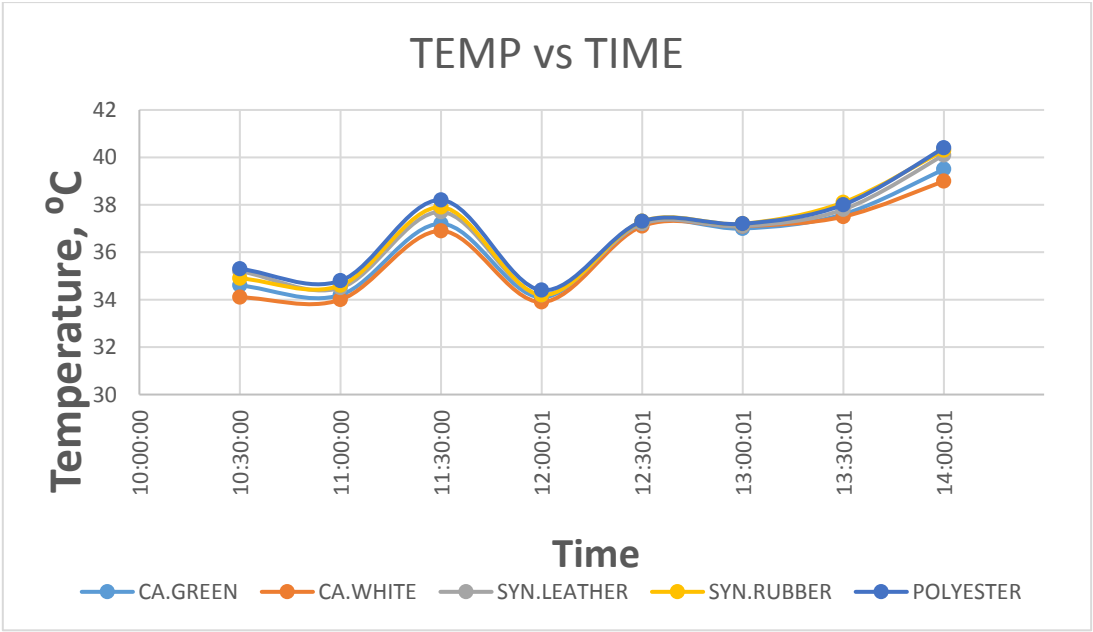

Fig 21: Temperature vs time (Day 3); Materials

4.2. RESULT & ANALYSIS

The observations were analysed statistically in SAS software. It was concluded that on all days.

1. Treatments (type of clothing materials) have significant effect on light intensity.

2. Treatments (type of clothing materials) have significant effect on temperature

3. Treatments (type of clothing materials) don't have significant effect on humidity.

Hence as observe the selection criteria for material were

1. Maximum light intensity(lux): recommended light level to work in outdoor condition is higher in the darkest day
2. Minimum temperature: recommended temperature for continuous work ranging from heavy, moderate and light work are 25^0C, 26.7^0C and 30^0C respectively.

Here the **canvas in white colour** was chosen as it gives least temperature and most light intensity

4.2.1. The result of the mobility test carried out in "3.2.2"

Observation of mobility test:

Particulars	No. of revolutions (n)	Distance covered (m)
On concrete	30	20.35
On undulated soil surface	30	32.25

Calculation:

Theoretical distance covered = $2 \times \pi \times r \times n$ ($r^{=}0.1$m, n=30)

$=2 \times \pi \times 0.1 \times 30$

$=18.84$ m

Slip/Skid (in %)

On concrete, %S = (Theoretical distance-Actual distance)/ (theoretical distance) x100

= (20.35-18.84) / (18.84) x 100

=8.1% skid

On soil surface, %S = (Theoretical distance-Actual distance)/ (theoretical distance) x 100

= (32.25-18.84)/ (18.84) x 100

=71.5 % skid

Result/Inference:

From test we got that skid percentage is more in the soil surface than the concrete which is due to excess soil moisture, undulated soil surface & geometry of wheel.

Conclusion:

From the test we concluded that mobility of the equipment is better in concrete than the undulated soil surface which is the actual requirement of the equipment.

4.3: The result of experiment for performance evaluation were carried out as explained in 3.2.4

The observations are tabulated below:

Table 4: Environmental parameter readings after covering

Time	**Environmental Parameters**	**Canvas White**	**Ambient**
09:00:00 am	Light intensity	6280	71800
	Relative humidity	57	56
	Temperature	35.2	37.8
09:30:00 am	Light intensity	4360	52700
	Relative humidity	48	48
	Temperature	36.4	38.7
10:00:00 am	Light intensity	6440	72200
	Relative humidity	48	48
	Temperature	36.8	38.9
10:30:00 am	Light intensity	4560	68500
	Relative humidity	47	46
	Temperature	39.1	40.2
11:00:00 am	Light intensity	3880	40200
	Relative humidity	50	47
	Temperature	38.4	39.1
11:30:00 am	Light intensity	3460	46100
	Relative humidity	60	60
	Temperature	35.5	36.5

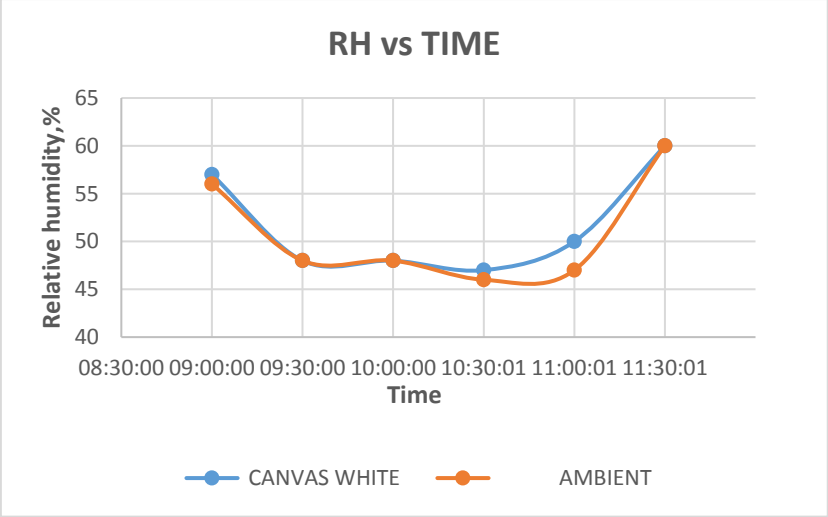

Fig 22: Relative Humidity vs Time

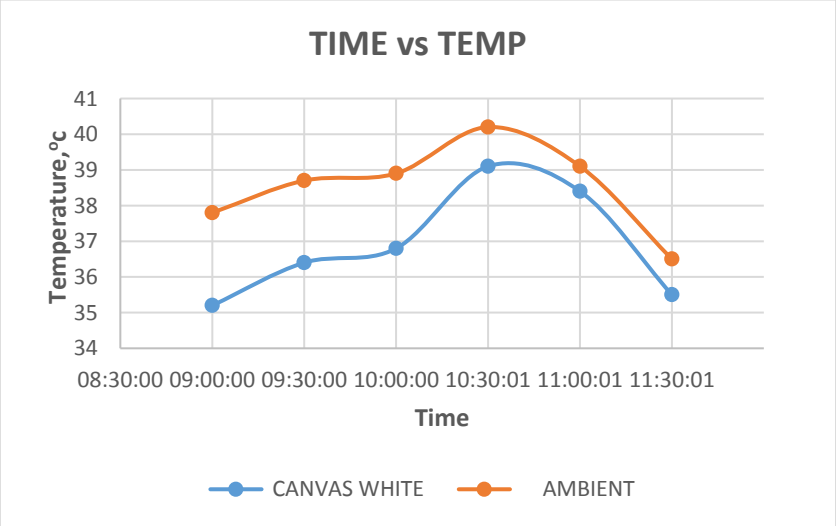

Fig 23: Temperature vs Time

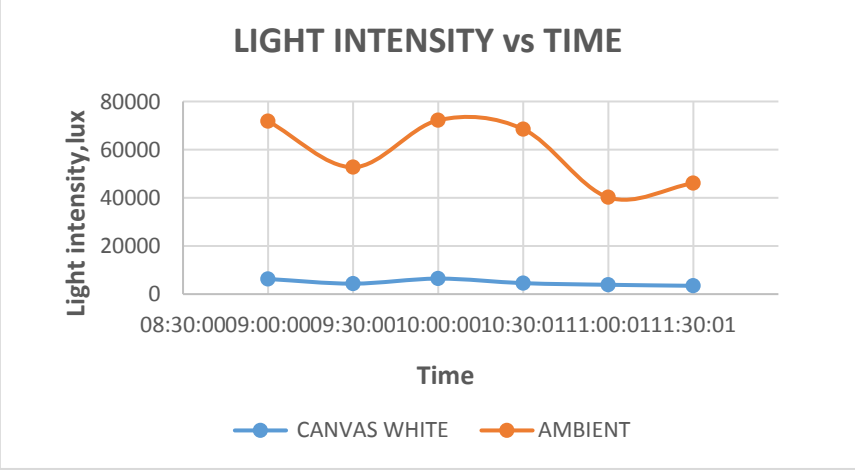

Fig 24: Light intensity vs Time

RESULT:

It can be concluded from the above observations (fig. 22, 23, 24) that the portable shed is effectively lowering the temperature while maintaining ample light intensity. This creates a comfortable working environment for the Indian labour, thus reducing the risk of heat stress. It is also suitable for monsoon season as it is leak-proof.

CONCLUSION:

This simple yet effective structure will considerable lower the drudgery & health hazard of farm women. It being gender friendly, men labours are also benefitted by the portable shed.

FUTURE SUGGETIONS

1. To avoid unnecessary skid it is suggested that the wheels may be equipped with a rubber surface or lugs.
2. Study of air flow in and around the portable shed may be carried out and suitable interventions may be done to facilitate proper ventilation.
3. Possibilities may be explored to convert the current model into a sitting type or self-propelled type shed.
4. Possibilities may be explored to attach solar panels for harvesting solar energy and using it to develop an artificial temp control system in portable shed.

REFERENCES

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