NICRA PROJECT

On

Assessing Resilience of Small Ruminant Production under Changing Climatic Condition in Semi-arid Zone

ANNUAL PROGRESS REPORT
(2013-2014)

Dr A. Sahoo
PRINCIPAL INVESTIGATOR

Central Sheep and Wool Research Institute
Avikanagar, Rajasthan

Co-operating Center
Division of Animal Physiology and Biochemistry
Central Sheep and Wool Research Institute
Avikanagar, Rajasthan - 304501

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2. **Reporting year: 2013-2014**

3. **Title of the project :** Assessing resilience of small ruminant production under changing climatic condition in semi-arid zone

4. **Name of the institute:** Central Sheep and Wool Research Institute Avikanagar, Rajasthan-304501

5. **Name of P.I.:** Dr A. Sahoo

6. **Name of the Associates with responsibilities:**

Dr Davendra Kumar	Management of animals and shelter and experiment on reproductive profile, data interpretation and report writing
Dr S.M.K. Naqvi	Planning and guidance on shelter and stress management
Dr O.H. Chaturvedi	Implementation of nutrition related experimental protocol, laboratory analysis, compilation and reporting
Dr Kalyan De	Implementation of experimental protocol, laboratory analysis, compilation and reporting
Dr Satish Kumar	Exploring HSP 70 gene and studying down and upward regulation profile of genes(s) to different stresses

7. Brief Technical Program implemented

Objectives

1. To study the adaptive capability of ewe and ram to compound abiotic stresses (thermal and water restriction) based on growth, physiological, endocrine and biochemical responses and reproductive performance
2. To identify the feeding and water managemental strategies to combat environmental stresses in sheep.
3. Evolving shelter management startegies to combat environmental stresses in small ruminants

Objective 1

To study the adaptive capability of ewe and ram to compound abiotic stresses (thermal and water restriction) based on growth, physiological, endocrine and biochemical responses and reproductive performance

Experiment 1. ***Effect of selenium-yeast supplementation on growth and physiological adaptability of Malpura ewes subjected to heat stress***

A study was conducted to assess the effect of selenium-yeast supplementation on growth and physiological adaptability of Malpura ewes subjected to heat stress. The experimental heat-stres period lasted for a period of 6 weeks involving 12 adult Malpura ewes. The ewes were randomly divided into two groups of 6 animals each viz., GI (Heat stress; n=6), GII (Heat stress + selenium-yeast supplementation n=6). The animals were stall fed with *ad libitum* feeding of a ration consisting of 70% roughage and 30% concentrate. Both the group ewes were maintained under controlled climatic condition and were exposed to increasing temperature starting from 38°C to 42°C in the climatic chamber. The animals were subjected to heat stress for 6 hrs a day between 10:00 to 16:00 h. Individual feed and water intake was recorded on daily basis. Physiological responses were recorded twice daily at weekly interval on day 0, day 7, day 14, day 21 day 28 and 35. Blood samples were collected on day 0, middle of the experiment (21 d) and at the end (42 d) for studying molecular profiling of stress-response gene.

Parameters studied

- Feed and water intake
- Change in live weight and body condition score
- Alteration in blood-metabolic profile
- Alteration in hormonal profile including reproductive hormones
- Alteration in oxidative stress response
- Effect on reproductive behavior, e.g. estrous and its duration

Experiment 2. ***Validation of protocol for the determination of the plasma volume with Evans Blue***

- Standardization of the protocol for the methods of Evans Blue for the determination of plasma volume
- Assessment of water intake and its distribution in body

Experiment 3. ***Differential expression of genes in sheep under different climatic stress condition***

Technical programme:

- Collection of periodic blood samples from animals exposed different stress conditions (detailed below)
- Standardization and validation of protocol for amplification of HSP 70 gene of sheep for deriving phylogenic relationship among different species and for determining expression and identifying new functions considering its importance in conferring thermotolerance
- Isolation of RNA from the blood samples and designing of primers
- Optimization of PCR conditions for the HSP family of genes
- Molecular characterization and sequencing of HSP70 and 90

Stress condition I

An experiment was conducted during peak summer season (May – June) for a period of 35 days. The ewes were randomly divided into four groups with 7 animals each viz., G-I (Control), G-II (20% water restriction), G-III (40% water restriction) and G-IV (*ad libitum* watering on alternate day).

Stress condition II

A total of 14 adult Malpura ewes were randomly divided into 2 groups of 7 animals each (GI- Control, GII- heat stress). G-I ewes were kept under shed, while G-II ewes were exposed to different temperatures at different hours of the day (38°C, 40°C, 42°C, 43°C, 44°C and 42°C h in the climatic chamber).

Objective 2

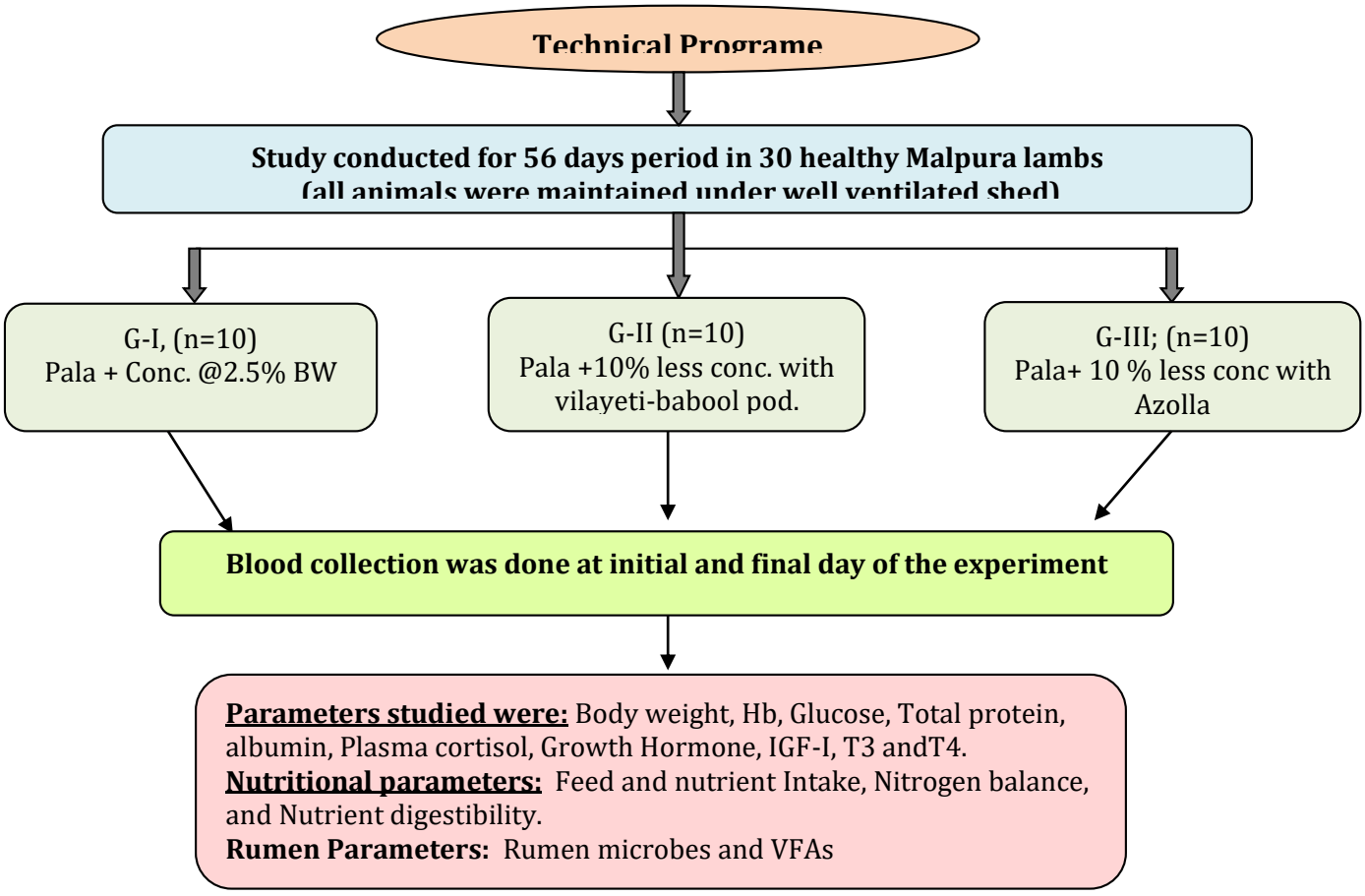
To identify the feeding and water managemental strategies to combat environmental stresses in sheep.

Experiment 1. ***Propagation and cultivation of Azolla (Azolla pinnata) in semi-arid regions as a biotic and protein supplement***

Work plan:

- Development of low-cost Azolla Production Unit at Institute Farm area
- Cultivation of *Azolla pinnata*, maintenance and harvesting for feeding of animals

Experiment 2. ***Incorporation of Azolla as a biotic feed source in the diet of native Malpura lambs during summer nutritional scarcity***



G-I, n=10

G-II, n=10

G-III, n=10

Experiment 3. ***Establishment of cactus field to provide biomass during hot summer***

Work plan:

- Field development, collection of cactus varieties and propagation
- Fencing of the cactus field with low-height concrete foundation reinforced with wire mat
- Maintenance of cactus filed: weeding, periodic re-propagation of stem
- Feeding experiment in sheep to assess acceptability, intake and nutritive value of different varieties of cactus

Experiment 4. ***Establishment of Senjana (Moringa oleifera) field to harvest biomass during scarcity***

Work plan:

- Field development, collection of saplings and propagation
- Fencing of the Senjana field with low-height concrete foundation reinforced with wire mat
- Maintenance of Senjana filed: weeding, periodic re-propagation of stem and occasional watering
- Feeding experiment in sheep to assess acceptability, intake and nutritive value of Senjana as a scarcity fodder

Experiment 5. ***Establishment of herbal garden with plants rich in secondary metabolites and herbal properties***

Work plan:

- Field development, plot-making for implantation of promising herb species
- Fencing of the Herbal garden with galvanized wire net reinforced with iron angles
- Collection of different herb species and propagation

Experiment 6. *Collection, drying and storage of monsoon herbage to feed during scarcity*

- Harvesting monsoon herbage namely, Chaulai and Jojhru
- Wire bed preparation for shade drying during monsoon
- Chaffing and preparation of feed block to store for the scarcity

Objective 3

Evolving shelter management startegies to combat environmental stresses in small ruminants

Experiment 1. ***Effect of different type shelters on physiological response, growth performance, blood biochemical and endocrine profile of lambs under hot semi-arid environment***

Technical programme: A study was conducted to see the effect of different types of shelter on physiological response, growth performance, blood biochemical and endocrine profile of lambs under hot semi-arid environment. Thirty three Malpura lambs of 3-5 months age (average body weight 19.5 kg) were used in the present study. The lambs were divided into three groups, viz. GI (control, lambs kept in conventional asbestos roof shed), GII (lambs kept in yagga type shed) and GIII (lambs keptopen area under tree-shade). The side walls of asbestos roof were made up of wire netted fencing where as in Yagga type shed; the side walls are double walled. The empty space between the two walls,were filled with sand. The sand was kept in moist condition by continuous water drip. The Yagga type shed was basically constructed with bamboo. Tree-shade was made the shade of large trees. The shaded area was protected by wire fence. The experiment was conducted for two months during extreme summer (May-june, 2013). The experimental set ups were fitted with maimum-minimum, dry and wet-bulb thermometer to record micro-environment profile. The lambs were provided with *adlibitum* green fodder, dry roughage and concentrate in an open area 0800 h to 1730 h. The detail experimental programme is given in the next page.

Effect of different types of shelter on physiological response, growth performance, blood biochemical and endocrine profile of lamb under hot semi-arid environment

Control **Yagya-type shed** **Tree-shade**

Protocol

G-I (Control, n=11) **G-II (Yagya type shed, n=11)** **G-III (Tree shade, n=11)**

Meteorological Data has been recorded twice at 8.00 hrs and 2.00 hrs per day. Parameter includes Dry bulb, Wet bulb temperature, minimum, maximum temperature, Relative humidity

Body Weight, Physiological Response and blood parameter has been observed fort nightly

Blood Biochemical's:- parameter includes; Hemoglobin (Hb), Packed Cell volume (PCV), Glucose, Total Protein, Cholesterol and Stress Enzymes through plasma.
Hormonal Parameter:- parameter includes; Metabolic Hormone:- T3, T4, Cortisol, GH



Work plan:

- Construction of low cost shed made up of local grass material to protect lambs from chilling cold
- Sheltering of lambs during night to protect from winter
- Record of climatological attributes e.g. environmental temperature, humidity
- Record of physiological response parameters to assess resilience against cold

Experiment 3. ***Establishment of Climate-resilient all-weather shed to protect from winter as well as summer***

Work plan:

- Area identification and shed orientation based on exposure to sunlight
- Construction of shed with partitioning to assess resilient against climatic stress management in sheep

8. Summary of work done

- **Amelioration of heat stress through selenium-yeast supplementation:** Supplementation of *Saccharomyces cerevisiae* grown in selenium enriched media provided resilience to counter heat stress in Malpura ewes.
- **Development of different shelters for protection against heat and cold stress:** A total of six different types of shelters were developed, viz. Yangya-type and Silvi-pasture system (Tree-shade) for protection against summer and portable Bamboo-Dome-type, small Hut type and low-ground Thermocol-insulated-type for protection against winter and a Climate-resilient all-weather shed (under construction).
- **Effect of different type of shelters on physiological response, growth performance, blood biochemical and endocrine profile of hogget's under hot semi-arid environment:** The open area tree-shade had higher THI than the other two housing types (asbestos and Yagya type). The animals sheltered in Yagya-type shed experienced maximum comfort with lower physiological responses, and relatively balanced haemato-biochemical and hormonal profile with better growth response.
- **Low cost shed establishment for protection of lambs during winter:** The shade was constructed with locally available material (*Panipuli*) that can be easily made by farmers in their field or during temporary stay en-route migration. The material is having insulation property because of its sharp blade leafs and is not usually consumed by the animals due to its tough plant structure and unpalatability.
- **Climate-resilient all-weather shed:** Construction of shed that can protect the animals throughout the year against all environmental stressor during climatic variability in different seasons is under progress.
- **Establishment of cactus field:** A cactus field that was developed in an area of 0.8 ha is expanded to 1.8 ha for implantation of different types of cactus (*Opuntia ficus-indica (L.) Mill*.) which were propagated successfully to provide feed biomass and water during summer scarcity.
- **Establishment of herbal garden:** An herbal garden was under establishment to harbour promising herbs having medicinal and veterinary care properties. A collection of plants rich in secondary metabolites would have promise to ameliorate nutritional and health anomalies including resilience against thermal and environmental stress. Establishment of the garden will act as a demonstration unit to the farmers as well as researchers.
- **Cultivation of Azolla (*Azolla pinnata*) as a biotic and protein supplement:** ***A***zolla is finding increasing use for sustainable production of livestock by providing a rich source of protein (CP 25%). It is reported to concentrate other plant biofactors (flavonoids, carotenoids) including vitamins and minerals. Part (10%) of the concentrate moiety of the ration was successfully replaced with Azolla on DM basis in the diet of sheep.

9. Results in detail

Objective 1

Experiment 1. ***Effect of selenium-yeast supplementation on growth and physiological adaptability of Malpura ewes subjected to heat stress***

Sachharomyces cerevisiae was successfully grown in Se-enriched media and was fed to ewes exposed to experimental heat stress in a climatic chamber having arrangements for thermoregulation. The effect on different response parameters was studied by exposing the animals to gradient increasing and decreasing temperature (38°C to 42°C) consecutively for 6 h starting from 10.00 AM to 4.00 PM. There was no significant difference in body weight, feed intake and water intake between the groups after 35 days of heat exposure. Physiological response was also did not differ significantly between the groups except pulse rate. It was significantly ($P<0.05$) higher in treatment group in morning. Plasma glucose level was also significantly ($P<0.05$) higher in Selenium fed animals as compared to control ewes. There was not much change in plasma glutathione reeducates activity but glutathione peroxidase activity increased in Se fed animals, where as it decreased in control groups as the experiment progressed. Cortisol level was higher in control animals as compared to control animals. Estrogen level was higher in treatment animals as compared to control animals; whereas reverse trend was found in progesterone level. Estrous response was also better in Se fed animals as compared to control (100% vs 83.3%). Estrous duration was longer in treatment group. It may thus be concluded that supplementation of *Saccharomyces cerevisiae* grown in selenium enriched media provided resilience to counter heat stress in Malpura ewes.

Table 1. Effect of Se-yeast feeding on body weight, feed intake and water intake

Parameters	**Control**	**Treatment**	**SE**
Initial body weight (Kg)	41.8	41.4	0.57
Final body weight (Kg)	41.6	41.5	0.51
BCS (Initial)	3.66	3.63	0.07
BCS (Final)	3.62	3.66	0.06
Feed intake (g/d)	54.46	54.61	0.88
Water intake (L/d)	4.17	4.11	0.06

Table 2. Effect of selenium-yeast feeding on physiological responses

Parameters	**Control**	**Treatment**	**SE**	**Control**	**Treatment**	**SE**
	Morning			**Afternoon**		
Respiration rate	35.07	34.60	2.22	97.06	95.93	2.70
Pulse rate	59.67[a]	64.33[b]	0.99	74.46	75.60	1.06
Rectal temperature	100.90	100.96	0.07	102.54	102.44	0.13

Table 3. Effect of selenium-yeast feeding on blood biochemical parameters

Parameters	**Control**	**Treatment**	**SE**
Hb	10.08	9.65	0.29
PCV	35.76	34.09	1.13
Glucose	50.20[a]	56.08[b]	1.58

Table 4. Effect of Se-yeast feeding on stress and reproductive hormones

Item	Cortisol (nmol/L)	Estradiol (pg/ml)	Progesterone (pg/ml)
Group effect	NS	NS	NS
GI	41.99	17.58	9.98
GII	32.21	19.56	7.46
Pooled SE for group	6.16	2.60	1.33
Week effect	NS	NS	NS
1st week	49.02	19.02	4.72
2nd week	50.39	15.90	11.28
3rd week	29.01	21.17	9.38
4th week	26.92	22.35	11.48
5th week	25.12	12.24	11.13
6th week	42.13	21.70	4.32
Pooled SE for week	10.23	5.14	2.30
Group*week	NS	NS	NS

Table 5. Effect of selenium-yeast feeding on glutathione peroxidase

Parameters	Control	Treatment	SE
Initial	0.165	0.114	0.04
End	0.148	0.154	0.038
Change	-0.018	0.040	0.042

Table 6. Effect of selenium-yeast feeding on glutathione reductase

Parameters	Control	Treatment	SE
Initial	0.032	0.029	0.004
End	0.031	0.027	0.004
Change	0.001	0.001	0.008

Table 7: Effect of selenium-yeast feeding on periodic changes in glutathione reductase profile in ewes exposed to heat stress

Week	Control	Treatment
1	0.018	0.031
2	0.032	0.029
3	0.031	0.011
4	0.015	0.019
5	0.031	0.027
6	0.031	0.027
Overall	**0.026**	**0.024**

Table 8: Glutathione peroxidase activity in control and Se-supplemented ewes exposed to heat stress

Week	Control	Treatment
0	0.165	0.114
1	0.143	0.133
2	0.237	0.17
3	0.124	0.132
4	0.068	0.105
6	0.15	0.154
Changes	**-0.03987**	**0.03987**

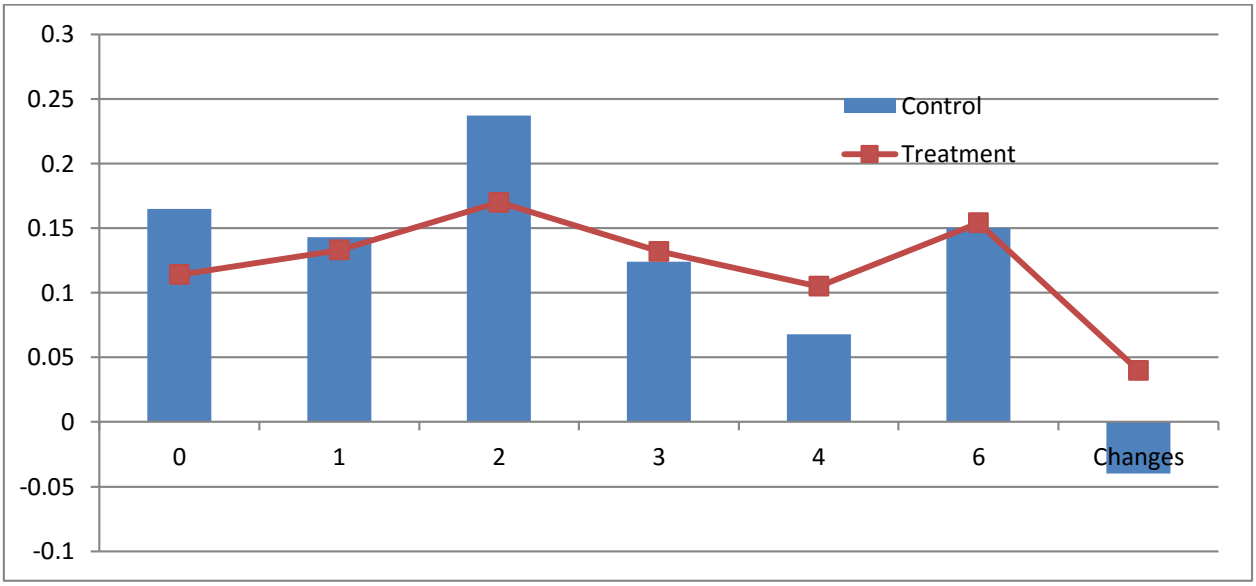


Fig 1: Weekly Glutathione peroxidase activity in control and Se-yeast supplemented groups.

Table 9. Effect of selenium-yeast feeding on reproductive behavour of ewes exposed to heat stress

Attributes	**Estrous %**		**Estrous duration (h)**	
Estrous %	G-I	G-II	G-I	G-II
Ist cycle(%)	83.3% (5/6)	100% (6/6)	39.6	44
II cycle(%)	83.3%(5/6)	100(6/6)	34.8	44

Experiment 2. ***Validation of protocol for the determination of the plasma volume with Evans Blue***

The method for the spectrophotometric determination of Evans Blue in plasma based on the precipitation of the non-albumin fraction of the plasma proteins with polyethylene glycol. Five different procedures currently are in use for the calculation of the plasma volume from the amount of indicator injected and the concentration at zero time (c0). Extrapolation to zero time of the early part (10 to 60 min) of the log concentration vs time curve yields the best estimate of the plasma volume. This technique can be simplified with minimal loss of accuracy, by using only one venous site for injection and withdrawal, withdrawing only three samples between 10 and 30 min after injection and using a two point calibration line.

Assessment of water intake and its distribution in animal system

WI = FWI + PW + MW + RW + IW

[WI, water intake (equals water loss); FWI, free water intake; PW, preformed water in or on food; MW, metabolic water; RW, released water (water released from tissue physiological pools plus ICF-water released on breakdown of protein (muscle); IW, inspired water].

Experiment 3. ***Differential expression of genes in sheep under different climatic stress condition***

The blood samples collected form sheep exposed to different stresses are processed and RNA was isolated from WBC cells and c-DNA has been prepared. Primers for the full coding region and qPCR of HSP gene family were designed (Table 1) and synthesized. PCR conditions for the HSP family of genes were optimized for molecular characterization. The sequencing of the HSP70 and 90 is under progress.

Table 1. Primers designed for the full coding region and qPCR of HSP gene family

S. No.	Gene ID	Nucleotide Sequences	Product Length
1.	HSP70	F5'ATGGCGAAAAACATGGCTATC3' R5'CTAATCCACCTCCTCAATG3'	1926bp
2.	HSP70	F5'GGTGCCCCAGATCGAGGTGAC3' R5'CACCCTCTCGCGCTGGACCTC3'	199bp
3.	HSP90	F5'GATGGAGGAGAGGAGGTGGA3' R5'AACATATTGGAGGGAACGGAGAC3'	1979bp
4.	HSP90	F5'CGGAAATTGCCCAGTTGATGTCAC3' R5'AGGGTTCGATCTTGCTTGTTC3'	196bp
5.	HSP40 BT	F5'AGACGCTACCTGATGGAG3' R5'TAACCTAAAGATAAAATACAAATG3'	1063bp
6.	HSP40 BT	F5'ACCTGATGGAGCTAGAAG3' R5'TGCTGTGATAAACCAAGGAG3'	187 bp
7.	HSP40 BT	F5'CAGGCAGACAATGCAACACC3' R5'CCAGGCACTGCTTCTGCTAT3'	158 bp
8.	HSP60 BT	F5' GGAGTCGGGCGATTGTATTC3' R5'GCACTATTCTAGGAGTTAGAACATG3'	1773 bp
9.	HSP60 BT	F5' GGAGTCGGGCGATTGTATTC3' R5'CCTTTTCTTCAGTCAGCTCCTTC3'	1871 bp
10.	HSP60 BT	F5' GGAGTCGGGCGATTGTATTC3' R5' CTTCCCTTTGGCCCCATAG3'	215 bp
11.	HSP60 BT	F5' TGGTCTTCAAGTTGTGGCAGTC3' R5' TGGCATCATCTTTGGTCACA 3'	188 bp
14	ACTB	F5'CCAACCGTGAGAAGATGACC3' R5'CCAGAGGCGTACAGGGACAG3'	97 bp

Objective 2

Experiment 1. ***Propagation and cultivation of Azolla (Azolla pinnata) in semi-arid regions as a biotic and protein supplement***

An extrapolation of Azolla production output per unit area provided an estimate of biomass production to the tune of 5 Q DM/ha area and with 25% CP would promise a potential biotic and protein source for semi-arid and arid regions of the country with minimum water use to harvest good quality protein for livestock feeding

Production output at CSWRI

90-100 q/ha/week = 450-500 kg DM/ha/week = 16-18 kg CP/ha/d

(Assumptions: DM 5%, CP 25%)

Low-cost pond for *Azolla pinnata* production

Experiment 2. ***Incorporation of Azolla as a biotic feed source in the diet of native Malpura lambs during summer nutritional scarcity***

After harvesting from the pond with a strainer Azolla needs proper washing to get rid of offensive odour if any. Since a fresh harvest Azolla has ~95% moisture, it is required to air dry under shade for 3-4 h (preferably air dried overnight on a nylon-net bed hanged from the ceiling for drainage of washed water and air circulation). It was observed that sheep took on an average 3 days' time for adaptation to Azolla based feed compared to conventional ration. In the present experiment, another unconventional source of feed 'Vilayati babool pods' was also incorporated in the ration to evaluate palatability, intake and nutritive value. On dry matter basis Azolla had 25% CP and 12% ash. The fat and total carbohydrates content were 4% and 57%, respectively. Following adaptation to Azolla the feed and DM intake was similar between the groups. Data on nutrient digestibility and other parameters will be compiled in due course. From the available information on feed intake and phenotypic performance of animals it may be concluded that Azolla could successfully replace 10% of concentrate in the the diet of sheep and also, Vilayati babool pods showed promise as an unconventional feed source with 18% CP to be incorporated as part of concentrate.

Experiment 3. ***Establishment of cactus field to provide biomass during hot summer***

A cactus field was developed in an area of 0.8 ha and enlarged in up to 1.8 ha for implantation of four different types of cactus (*Opuntia ficus-indica (L.) Mill.*) propagated successfully to provide feed biomass and water during summer scarcity.

Activity 1: Development of a field for cactus implant

0.8 ha area of cactus

Newly developed 1.0 ha area for cactus

Activity 2: Collection of different variety of cactus and propagation of cactus

Opuntia ficus-indica

Trichocereus pachanoi

Opuntia inaperta

Platyopuntia cactus

Experiment 4. ***Establishment of Senjana (Moringa oleifera) field to harvest biomass during scarcity***

Moringa oleifera: A promising fodder biomass for semi-arid Rajasthan

A 0.5 ha area with Senjana (*Moringa oleifera*) implants was developed to provide biomass during scarcity. Commonly known as "Drumstick" tree, it has gained interest as a protein source for livestock. It was observed that Moringa could easily be established in the field and has good coppicing ability to promise as a potential source of forage during scarcity. With a DM content ranging from 16-28%, the foliage had average 18% CP and 11% ash. A preliminary palatability trial has been conducted in sheep on conventional ration and it was observed that none of the animals did show rejection even on day 1 and thus proved good palatability. The feeding trial with 500 g of fresh foliage over and above the conventional ration based on concentrate 1% of body weight with ad libitum dry cenchrus grass was conducted and the assessment of feed and nutrient intake and its nutritive value is under progress.

Experiment 5. ***Establishment of herbal garden with plants rich in secondary metabolites and medicinal properties***


Field for growing herbal plants

Experiment 6. ***Collection, drying and storage of monsoon herbage to feed during scarcity***

Monsoon herbage biomass is generally neglected due to availability of enough pasture during rainy season. However, a huge amount of palatable forage biomass can be harvested, shade dried and stored for future scarcity periods of the year. The two identified herbages Chaulai and Jojhru were grown soon after monsoon and at the end of monsoon period and observed to be consumed by sheep during foraging. These forage biomass was harvested and analysed for nutrient composition (Table 1)

Table 1. Nutrient composition of different monsoon herbages

Botanical name	Common name	DM	OM	CP	EE	TCHO	NDF	ADF	Lignin	HC	C	Ash
Amaranthus spp	Chaulai	14.7	88.3	17.61	4.87	65.9	61.5	32.9	6.19	28.6	26.7	11.67
Crotalaria medicaginea	Jhojhru	29.9	90.0	13.88	3.11	73.0	55.1	20.2	6.95	34.9	13.2	10.05

DM Dry matter, OM Organic matter, CP Crude protein, EE Ether extract, TCHO Total carbohydrates, NDF Neutral detergent fiber, ADF Acid detergent fiber, HC Hemicellulose, C Cellulose



Amaranthus sps. ***Crotalaria medicaginea Lam*** ***Shade drying of monsoon herbage***

Objective 3

Experiment 1. ***Effect of different type shelters on physiological response, growth performance, blood biochemical and endocrine profile of lambs under hot semi-arid environment***

To ameliorate heat stress, open area **silvi-pasture system with fodder trees to provide shade** was developed with an objective to protect animals from solar radiation during extreme summer as well as to provide fodder during scarcity period in semi-arid region.

Integrated farming with tree-shade for protection against summer

Yagya-type shed was constructed to protect the animal from extreme summer. This concept was taken from The Hindu rituals, where they used to construct special type of structure to perform Havan (yagya). That structure used to keep the shed comfortable inspite of continuous fire and burning of woods inside the shed. Similarly here we have constructed a modified shed that can provide comfort during summer. The shed was made up of bamboo. The side walls were double walled. The empty space between two walls was filled with sand. The sand was kept in moist condition through continuous drip water system. This provide evaporative cooling inside the shed, that kept the inside micro environment comfortable.

Yagya-type shade for protection against summer

Experimental findings: The open area tree-shade had higher THI (table 1) than the other two housing types (asbestos and Yagya type) and animals exhibited more discomfort (high respiration rate, pulse rate). The animals showed higher metabolic rate as exhibited from their high T3 values (fig.3). Amongst the three housing types, Yagya-type shed provided maximum comfort with lower physiological responses (table 3). The animals kept in this shed also had relatively balanced haemato-biochemical (fig. 1) and hormonal profile (fig. 2) with better growth response (table 2).

Table 1. Environmental data for Yagga type shed during summer

	Max T (°C)	Min T (°C)	RH (°C)	THI at 1400 h
Environmental	43.46±0.44	26.19±0.56	23.61±1.91	37.60±0.38
Asbestos roof	45.48±0.51	27.09±0.52	18.95±1.96	33.73±1.23
Yagya	41.42±0.47	27.92±0.91	21.16±1.6	32.42±1.26

* Max T-Maximum Temperature, Min T- Minimum Temperature, RH- Relative Humidity, THI- Temperature Humidity Index. (Marai et al. 2007)

Table 2. Effect of different type of shelters on growth performance

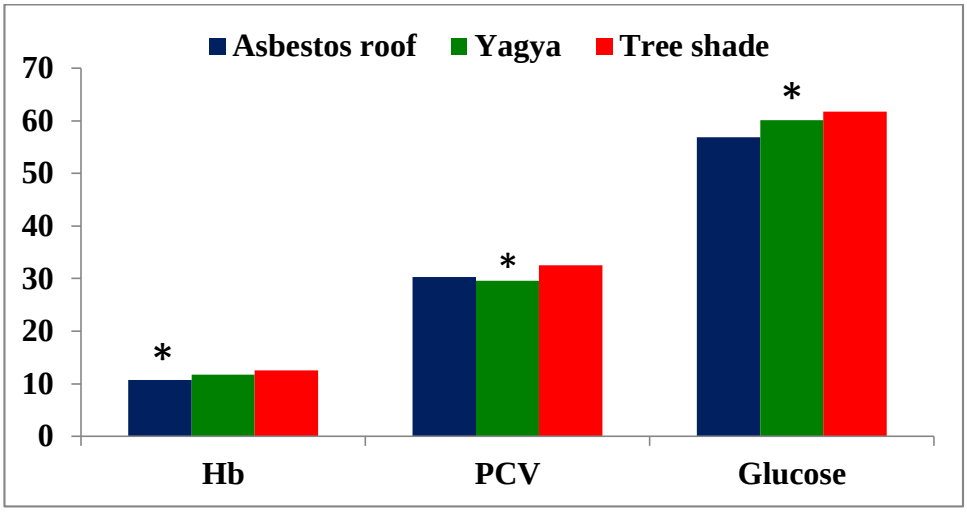
	Initial weight (kg)	End weight (kg)	Weight gain (kg)	ADG (gm)
Asbestos roofed	19.49±0.74	25.19±1.40	5.70±1.31	94.99±21.74
Yagya Type	19.44±0.74	26.19±1.40	6.75±1.31	112.57±21.74
Tree Shed	19.64±0.70	25.30±1.34	5.67±1.24	94.45±20.73

Table 3: Effect of different type of shelters on Physiological response

Item	RR Morning	RR Afternoon	PR Morning	PR Afternoon	RT Morning	RT Afternoon
μ ± SE	20.30±0.41	54.47±1.14	54.92±0.69	61.90±1.01	101.49±0.06	102.09±0.06
Treatment	*	**	*	*	NS	*
Asbestos roof	22.28^{a}	46.05^{b}	56.61^{a}	65.97^{a}	101.44	102.13^{ab}
Yagya	18.57^{b}	33.62^{c}	51.85^{b}	57.42^{b}	101.43	101.90^{b}
Tree shed	20.06^{ab}	83.73^{a}	56.30^{a}	62.31^{a}	101.60	102.24^{a}
Pooled SE for treatment	±0.70	± 1.97	± 1.19	± 1.75	± 0.10	± 0.10
Week	**	**	**	**	**	NS
1st	23.20^{a}	39.64^{b}	61.67^{a}	74.60^{a}	102.03^{a}	102.27
2nd	21.50^{a}	56.23^{a}	58.28^{a}	60.49^{b}	101.49^{b}	102.16
3rd	15.95^{b}	59.01^{a}	49.33^{b}	57.13^{b}	100.95^{c}	102.06
4th	20.56^{a}	62.99^{a}	50.40^{b}	55.38^{b}	101.49^{b}	101.86
Pooled SE for day	± 080	± 2.26	± 1.37	± 2.01	± 0.12	± 0.11
Treatment*week	*	**	*	*	**	*

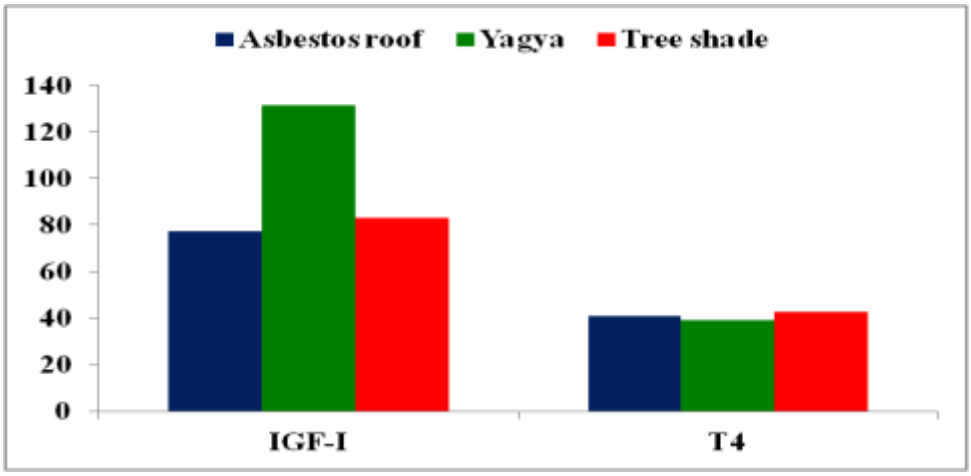
RR; Respiration rate (breath/ Minute), PR; Pulse rate (beat/Minute) and RT; Rectal temperature (°F), μ indicating overall mean, **(p<0.01) differ significantly * (p<0.05) differ significantly

Fig 1. Effect of Shelter on Blood Biochemical's of lambs under hot semi arid environment



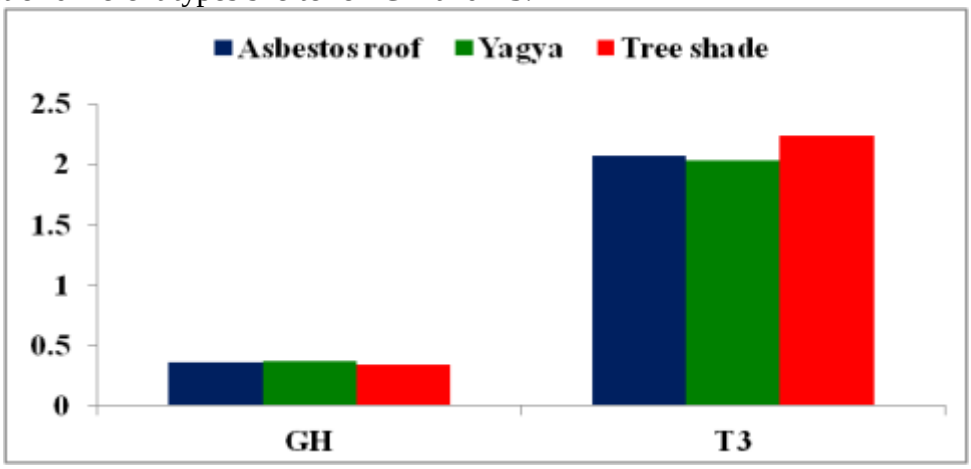
Hb; Haemoglobin (g/dl), PCV, Packed cell volume (%), Glucose(mg/dl) and * (p<0.05) differ significantly

Fig 2. Effect of different types shelter on IGF-1 and T4.



IGF-I; Insulin-like growth factor-1(ng/mL) and T-4; thyroxine (nmol/L)

Fig 3. Effect of different types shelter on GH and T3.



GH; Growth Harmone and T3 triiodothyronine (nmol/L)

Experiment 2. ***Development of low-cost shed to protect lambs from cold stress***

Establishment of low cost shed for protection of lambs during winter. The shade was constructed with locally available material (*Panipuli*). The material is having insulation property.

Low cost Hut- type shed for cold protection

Experiment 3. ***Establishment of Climate-resilient all-weather shed to protect from winter as well as summer***

10. Results of Significant value

- **Amelioration of heat stress through selenium-yeast supplementation:** Supplementation of *Saccharomyces cerevisiae* grown in selenium enriched media provided resilience to counter heat stress in Malpura ewes.
- **Yagya-type shed to provide more comfort during summer**: The microenvironment inside the yaga type shed provide better comfort then asbestos roofed shed and open-area tree shade (THI reduction by 5 unit).
- **Low cost shed for protection of lambs during winter:** The shade was constructed with locally available material (*Panipuli*) that can be easily made by farmers in their field or during temporary stay en-route migration. The material is having insulation property because of its sharp blade leafs and is not usually consumed by the animals due to its tough plant structure and unpalatability.
- **Azolla as biotic and protein supplement**: 10% replacement of concentrate with Azolla provided additional protein besides as a source of green
- **Cactus: resilient against feed and water scarcity:** With 88% moisture, consumption of 2.0 kg cactus biomass could provide 240 g feed DM with and 1.76 L water.
- **Harvesting monsoon herbage to cater summer feed scarcity**: Promising plant species (e.g. Chaulai, Jojhru) that erupts during monsoon could be harvested, dried under shade and stored to feed during summer scarcity

11. Procurement of Equipment: Nil

Name of the Equipment	Status of Procurement	Estimated Cost/ Budget allocated (Rs. in lakhs)	Actual Cost
.			

12. Status of works, if any:

Name of the Work	Actual expenditure incurred
1. 1.8 ha Cactus farm	79,452/-
2. Establishment of a herbal garden (approx.. 2.0 ha)	45,500/-
3. Climate-resilient All-weather shed	1, 98,000/-
4. Boundary Wall around cactus and Senjana farm	1,99,000/-
Total	**5,21,952/-**

13. Budget details:

Head	Opening balance (Rs) (01-04-13)	2013-14	Cumulative (2013-14)		
		Release	Received	Exp.	%
I. RC	**-**				
i. Operational		**1447219***	**2500000**	2378889	95.16
ii. TA		-	100000	58948	58.95
iii. HRD		- -	-	-	
II. NRC	**-**	**-**			
i.		-	-		
ii.		-	-		
iii.		-	-		
III. Inst Charges			**-**		
IV. Total	**1152781**	**1447219***	**2600000**	**2437837**	**93.76**

*NB. Total amount received including CIRG Rs 3053967/-; Amount credited to CIRG Rs 1000000/- and amount to be transferred to CRIDA (meant for CIRG) Rs 606748/-; So, **Balance released for CSWRI for the year 2013-14 = Rs 3053967 – 1000000 - 606748 = Rs 1447219**

14. HRD Program conducted, if any:

Name of the programme	Venue	Dates (DD/MM/YYYY)	No. of participants
One day workshop on "Climate resilient shelter and stress management in small ruminants in hot arid and semi-arid regions of india"	CSWRI, Avikanagar	02-05-2013	Delegates- 03 Scientists-19 Farmers-65
Field Day	CSWRI, Avikanagar	24-03-2014	Technical Off. 10 Scientists-30 Farmers-61

- One day workshop on "Climate resilient and stress management in small ruminant in hot arid and semi-arid region of India" was held at CSWI, Avikanagar on 2nd May, 2013. Three delegates, nineteen scientists and sixty five farmers attended this workshop.
- Trainees under different programme at CSWRI, Avikanagar were exposed to different shelter management strategies under NICRA.
- Farmers involved in training programme at CSWRI were visited to Cactus field area and given knowledge regarding its importance during summer food and water scarcity.
- Resource persons and dignitaries visited to CSWRI, were introduced the different shelter and nutritional management activities carried out & going on under NICRA project at CSWRI, Avikanagar

14. Publication/ patents

A. Research papers

1. Sejian, V, Naqvi, S.M.K., Sahoo, A. 2013. Effect of mineral mixture and antioxidant supplementation on growth, reproductive performance and adaptive capability of Malpura ewes subjected to heat stress. *Journal of Animal Nutrition and Animal Physiology,* 98, 72-83.
2. De K., Kumar D., Singh A.K., Sahoo, A. and Naqvi, S.M.K. 2013. Seasonal variation of physiological response in ewes of farmers' flocks under semiarid tropical environment, Biological Rhythm Research, DOI: 10.1080/09291016.2013.830509

B. Scientific/Teaching Reviews/Lead Paper

1. Sahoo, A. 2013. Nutritional issues in grazing and migratory sheep and goats. Centre of Advanced Faculty Training in Animal Nutrition is organizing an advanced Short Course on "Clinical Nutrition Approaches for Health and Productivity of Farm Animals", February 06-26, 2013, IVRI, Izatnagar. pp 174-181.
2. Naqvi S.M.K., Davendra Kumar and Sahoo A. 2013. Strategies for sustainable small ruminant production in arid regions under changing climate. In: Proc. Workshop on "Strategies for sustainable small ruminant production in arid regions under changing climate", 14-15, March, 2013, CAZRI, Jodhpur.

C. Folders:

1. Chaturvedi, O.H., Sahoo, A., Bhatt, R.S., Sankhyan, S.K., Shinde A.K. and Meena, M.C. 2013. Akal Men PashudhanKaBharanPoshan. Published By NICRA, CSWRI, Avikanagar.
2. Sahoo, A. Chaturvedi, O.H., Sharma, S.C., Meena, M.C., Naqvi, S.M.K. 2014. "वर्षाकालीन शाकीय – जड़ी बूटीयों का पशुओं के चारे में उपयोग"Published By NICRA, CSWRI, Avikanagar
3. Sahoo, A. Chaturvedi, O.H., Sharma, R.B., Meena, M.C., Naqvi, S.M.K. 2014. "Monsoon herbage and weeds: Could be an answer to feed scarcity" Published By NICRA, CSWRI, Avikanagar

D. Abstract papers

1. Chaturvedi, O.H. and Sahoo, A. 2013. Opuntia (prickly pear cactus) feeding in sheep to evaluate water and nutrient metabolism during summer. *In Souvenir Cum Compandium of Intractive Meeting on Prospects in Improving Production, Marketing and Value Addition of Carpet Wool.* December 31, ARC (CSWRI) Bikaner, India. Pp. 58.
2. De K., Kumar D., Singh A.K., Sahoo, A. and Naqvi, S.M.K. 2014. Effect of microenvironment manipulation on physiological response, blood biochemical, behaviour and growth of Malpura lambs during winter in semiiarid tropical condition. In: XXI Annual convention of Indian Society of Animal Production and Management and national seminar on "New Dimensional Approaches for Livestock Production and management, January 28-30, 2014, pp 20.

15. Any other information:

1. Dr Kalyan Dey attended workshop on NICRA activities at CAZRI, Jodhpur.
2. Dr A. Sahoo and Dr Davendra Kumar attended an Intractive Meeting on "Prospects in Improving Production, Marketing and Value Addition of Carpet Wool". December 31, 2013 ARC (CSWRI) Bikaner,
3. A 'Field Day' under the project on National Initiative on Climate Resilient Agriculture (NICRA) was organized on 24th March, 2014 at Central Sheep and Wool Research Institute, Avikanagar. Professor M.P. Yadav, Secretary, NAAS presided the meeting as Chief Guest. Two folders, one in Hindi "वर्षाकालीन शाकीय – जड़ी बूटीयों का पशुओं के चारे में उपयोग" and one in English "Monsoon herbage and weeds: Could be an answer to feed scarcity" were released in this occasion.
4. About fifteen farmers visited Azolla production unit under NICRA at CSWRI, Avikanagar in March, 2014.
5. The scientist delegation from Bangladesh namely, Dr. Md. Nazrul Islam, Director General, Bangladesh Livestock Research Institute, (BLRI), Mrs. Delwora Begum, Deputy Secretary, Ministry of Fishery & Livestock (MOFL), Dr. Md. Ershaduzzaman, Project Director (Sheep Project), BLRI, Pulakash Mondal, Senior Assistant Chief, Ministry of Fisheries and Livestock and Md. Tanjim, Assitant Chief Planinig Commission have visited NICRA activities during their study tour to CSWRI, Avikanagar on 06.04.14.
6. Dr Fisal Hassan Ibrahim, Minister of Animal Resource, Republic of Sudan and H.E. Hon. visited NICRA activities during their study tour to Central Sheep and Wool Research Institute, Avikanagar on 6th March 2014.