

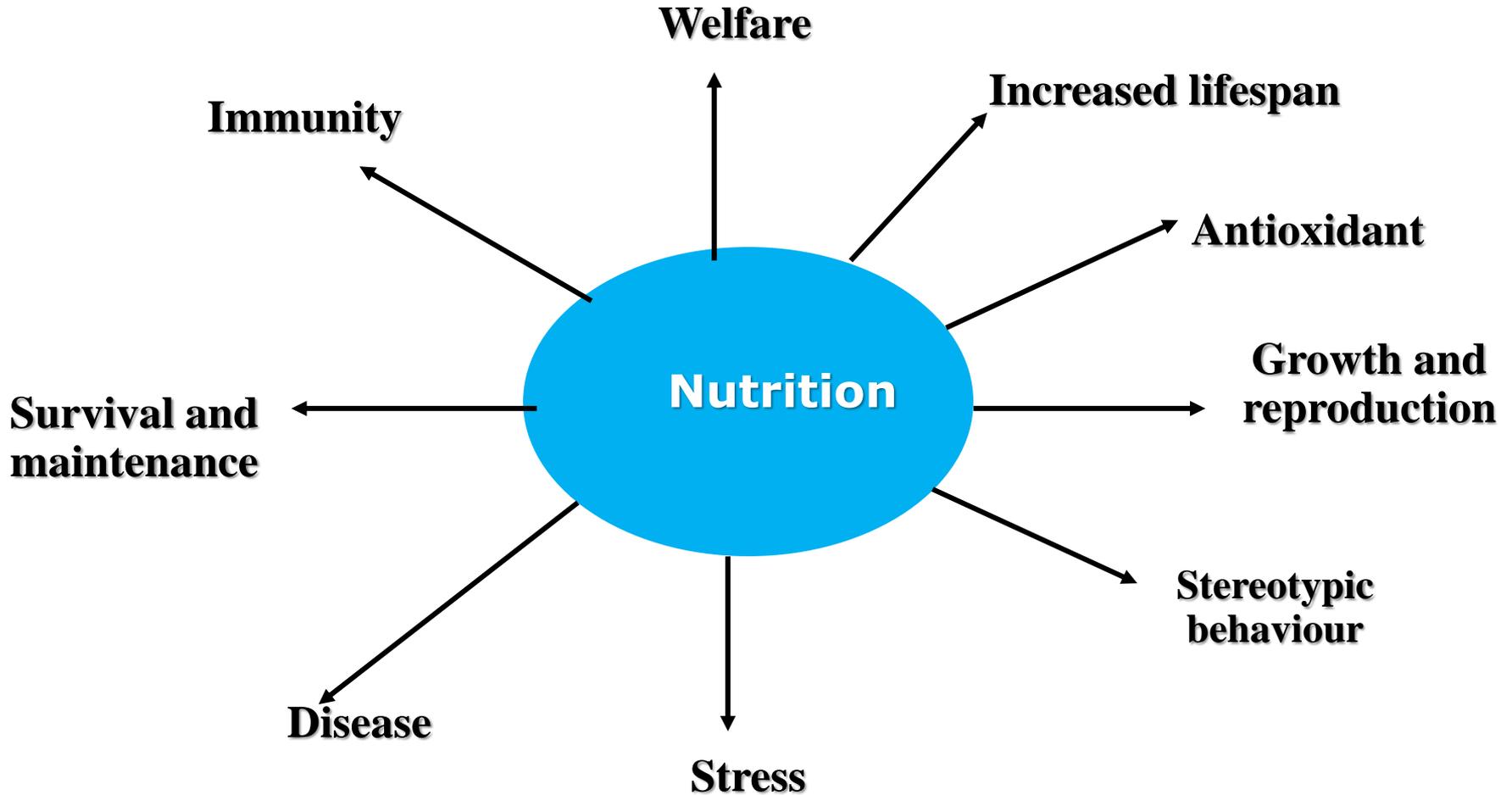
# **ANIMAL DIET: EXISTING SCENARIO AND FUTURE COURSE (ANN-607)**



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Nutritional disorders kill slowly and smartly so as the ultimate blame goes on to some other pathological agent.

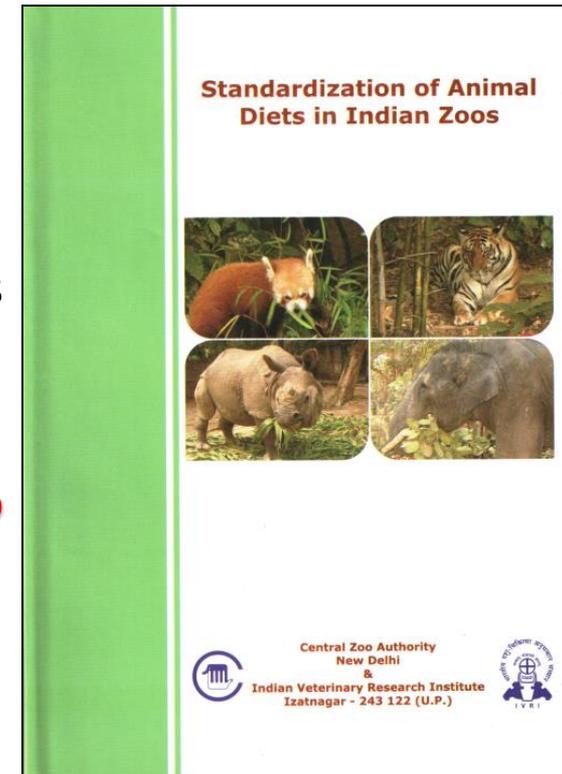
## Strength

1. Feeding of natural feed ingredients
2. Adequacy of Ca in captive carnivores diet
3. Behavioural stimulation and attempts towards enrichment

## Weaknesses

1. Excessive feeding of grains and concentrates to herbivores
2. Excessive feeding of meat to carnivores
3. Micronutrients (especially Zn and Cu ) deficiency was widespread among herbivores

## Book published by CZA

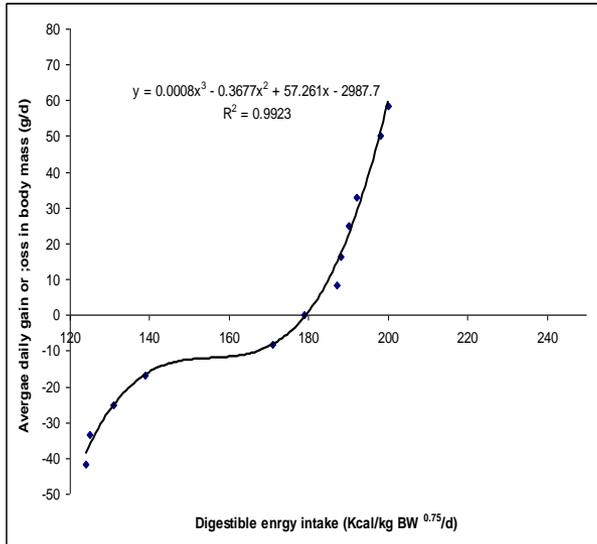


•34 zoos

•50 species of birds, reptiles and mammals

•Nutrient analysis, digestion and feeding trials

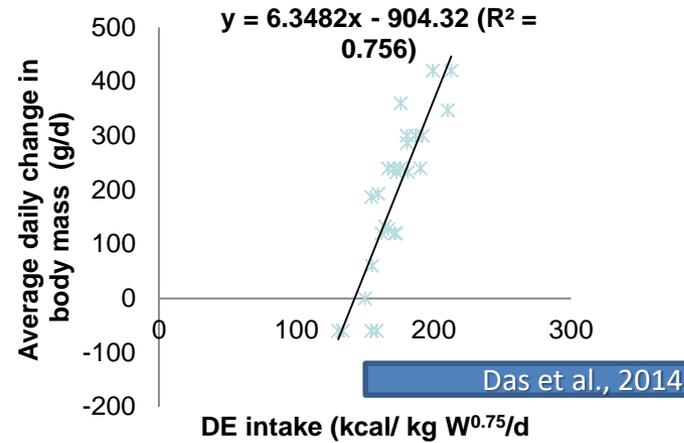
# Understanding the energy needs of zoo animals



Spotted deer

Suresh et al., 2013

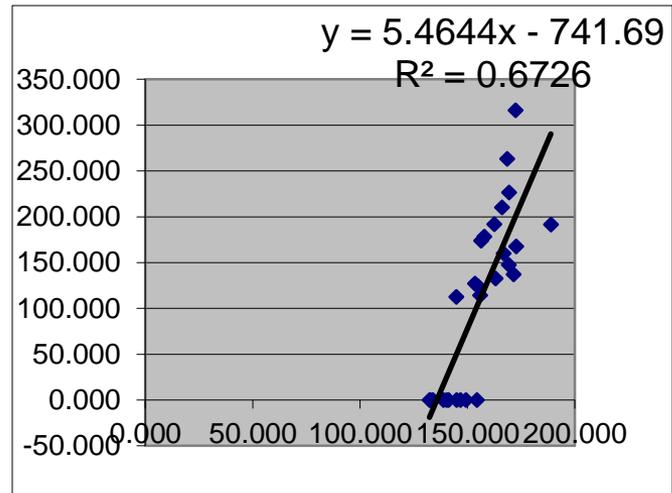
Relationship between digestible energy intake (kcal/ kg BW<sup>0.75</sup>) and average daily change in body mass (g/d) in captive herbivores



Asian elephant

$$y = 5.4644x - 741.69$$

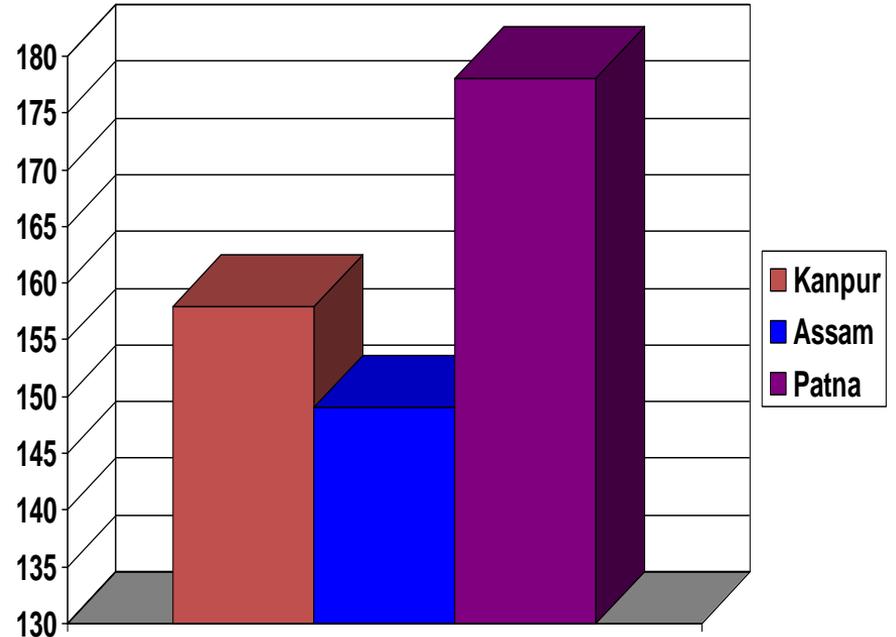
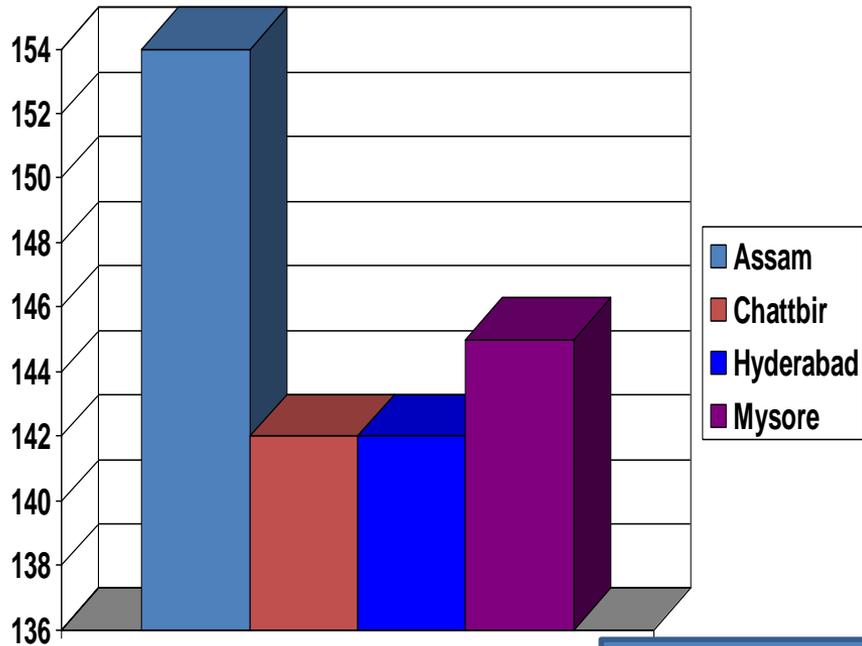
$$R^2 = 0.6726$$



Indian rhinoceros

Kumar, 2013

# DE intake (kcal/kg BW 0.75/d) by elephants and rhinoceros in different zoos



Das et al., 2013b

Are mega-herbivores in Indian zoos receiving extra  
calorie????

## Feeding of grains and concentrates

- How much is too much ???

Species	Desirable amount	Amount being fed
Spotted deer	0.50 kg	1- 2.3 kg
Blackbuck	0.25 kg	0.25-0.80kg
Swamp deer	1.0 -1.25 kg	1.5 kg-2.5
Brow antlered deer	0.50 kg	1.0- 1.5 kg
Wild ass	1 kg	1 kg
Indian rhinoceros	Male ( 2200 kg): 3 kg Female ( 1600 kg): 2kg	2.7 -9.2
Asian elephant	Male (4 t) : 6 kg Female (3.5 t): 5 kg	5-14 kg

**Concentrates should never be used as a primary source of calorie**

## Feeding of grains and concentrates

- Disturbed metabolism**

Species	Attributes		
Spotted deer	Amount of concentrates being fed		
Das et al., 2013a, 2010	0	0.5 kg/ head/ d	1 kg / head /d
Glucose (mg/dl)	97.6 <sup>a</sup> ±1.31	109.7 <sup>b</sup> ±1.26	111.5 <sup>c</sup> ±1.03
Cholesterol (mg/dl)	97.5 <sup>a</sup> ±1.00	106.7 <sup>b</sup> ±1.19	111.0 <sup>c</sup> ±1.17
Elephant	Amount of concentrates		
Das et al., 2014	0.18% BW	0.12 % BW	0.06% BW
Glucose (mg/dl)	74.8 <sup>a</sup> ±0.49	69.7 <sup>b</sup> ±0.91	65.7 <sup>c</sup> ±0.80
Cholesterol (mg/dl)	85.3 <sup>a</sup> ±5.66	83.1 <sup>a</sup> ±3.65	68.1±2.95

## Consequences of feeding excessive concentrates

1. Rumen dysfunction

2. Disturbed metabolism

3. Obesity

4. Reduced reproduction

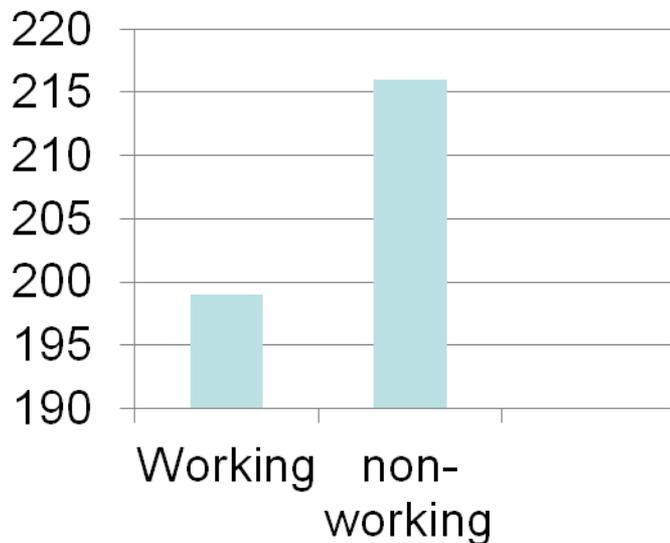
5. Hoof problems

	Amount of concentrates fed		
	0	0.5%	1% BW
	BW		
Glucose	75.80a	96.40b	99.00 b
(mg/dl)**			
Cholesterol	58.60 a	62.40 ab	74.40 b
(mg/dl)**			

Serum metabolite profile of blackbuck fed different levels of concentrates

## Moderate work is beneficial for Asian elephants

### DE intake per kg metabolic body size



Four hours of tourist work has no adverse impact on food consumption and blood metabolite profile of semicaptive Asian elephants, rather digestibility of nutrients was improved in working elephants. Work showed positive effect in restricting the calorie supply closer to requirement. It was concluded that 4 h of work is beneficial for captive Asian elephants.

Katole et al., 2013

## Can roughages be fed ad lib. ??????????

Parameters	Amount of rohini tree fed (kg/ elephant / d)		
	120	100	80
DE (kcal/kgBW <sup>0.75</sup> )*	198.55 <sup>a</sup>	186.07 <sup>ab</sup>	166.37 <sup>b</sup>
Serum Glucose (mg dl <sup>-1</sup> )**	82.83 <sup>a</sup>	77.33 <sup>b</sup>	73.17 <sup>c</sup>
Urea (mg dl <sup>-1</sup> )**	28.17 <sup>a</sup>	24.66 <sup>b</sup>	23.43 <sup>b</sup>
Cholesterol (mg dl <sup>-1</sup> )*	64.15 <sup>a</sup>	62.82 <sup>b</sup>	63.36 <sup>b</sup>
Creatinine (mg dl <sup>-1</sup> )	1.53	1.383	1.442

Katole 2012

Amount of Rohini fed to semi-captive Asian elephants (3400 kg BW) should be restricted to 100 kg. Feeding of Rohini at this level ensured adequate supply of CP, Ca, P, Co, Fe and Zn to fulfill requirement of semi-captive elephants.

**Feeding roughages ad lib. could be problematic**

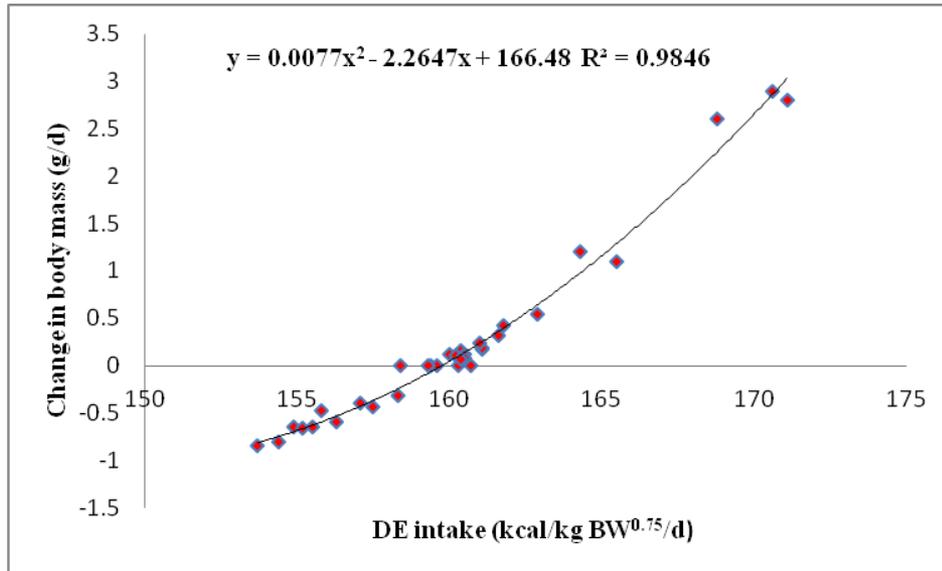
## Feeding of green fodder and roughages

- Suggested guidelines according to our research\*

Species	Concentrates (~90 % DM)	Roughages (~25% DM)
Spotted deer	0.50 kg	leguminous fodder: 3.5 kg cereal fodder : 3 kg
Blackbuck	0.25 kg	3 kg
Swamp deer	1.0 -1.25 kg	10-12 kg
Brow antlered deer	0.50 kg	7- 9 kg
Wild ass	1 kg	15 kg
Indian rhinoceros	Male ( 2200 kg): 3 kg Female ( 1600 kg): 2kg	110 kg 150 kg
Asian elephant	Male (4 t) : 6 kg Female (3.5 t): 5 kg	225 kg 200 kg

\*Similar guidelines suggested for 18 species of herbivores

## Understanding the energy needs of captive felids



Pradhan, 2013

**Correlation between the DE intake (kcal/kg BW<sup>0.75</sup>/d) and change in body mass (g/d) in captive Indian leopard (*Panthera pardus fusca*) fed conventional zoo diet**

Species	DE intake
Leopard	166- 182
Cheetah	150- 185
Clouded leopard	100-120
Tiger	160--251

**DE intake (kcal/kg BW<sup>0.75</sup>/d) at which captive felids can maintain body mass**

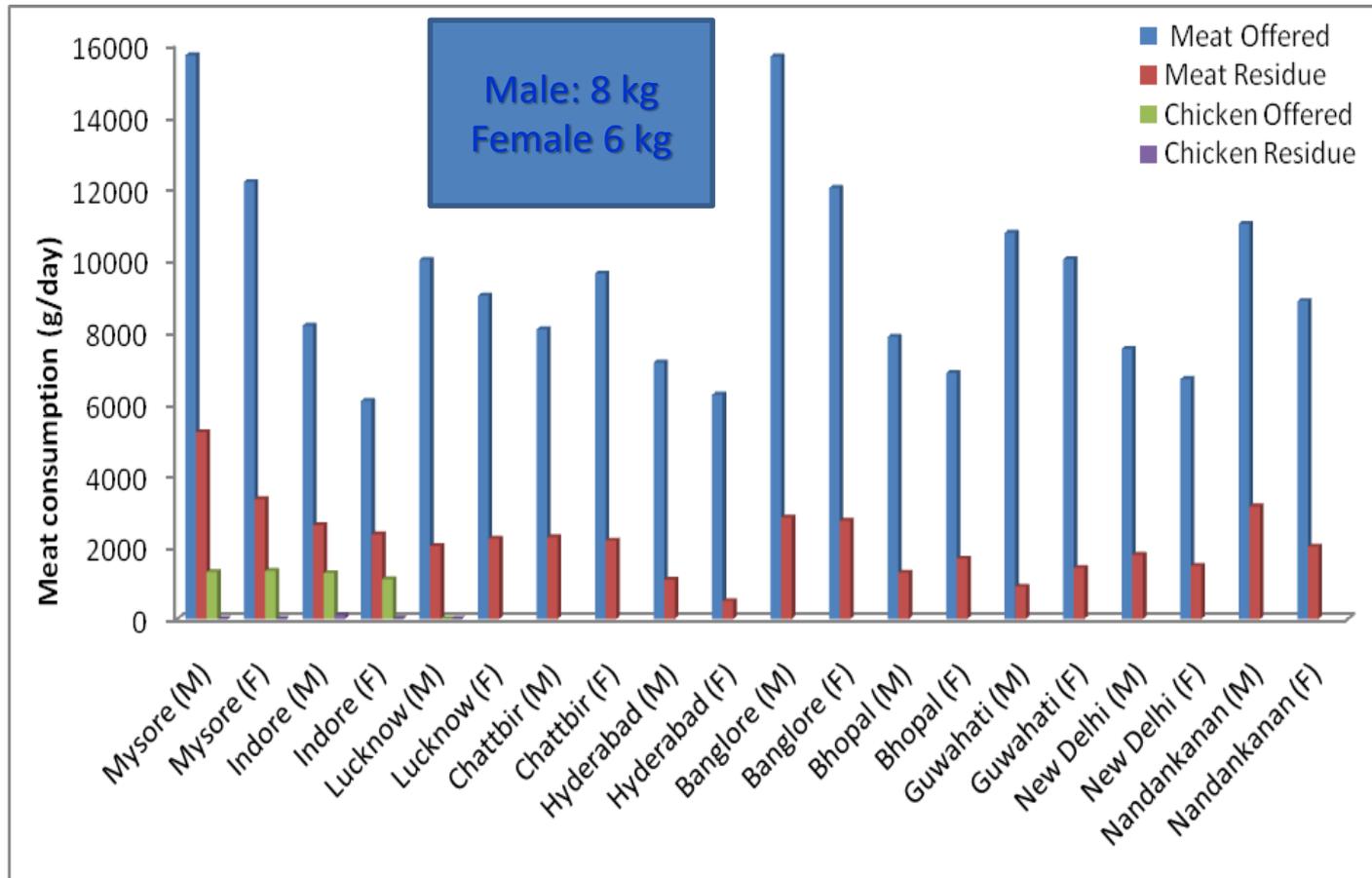
## DE (kcal) intake in tigers in different Indian zoos

Zoo		Per day	Per kg BW <sup>0.75</sup>
Mysore	Male	<b>19312</b>	<b>327</b>
	Female	<b>17482</b>	<b>430</b>
Indore	Male	<b>11964.3</b>	203
	Female	<b>7988.4</b>	196
Lucknow	Male	<b>18607</b>	<b>315</b>
	Female	<b>15294.8</b>	<b>376</b>
Chattbir	Male	<b>10446</b>	177
	Female	<b>13063</b>	321

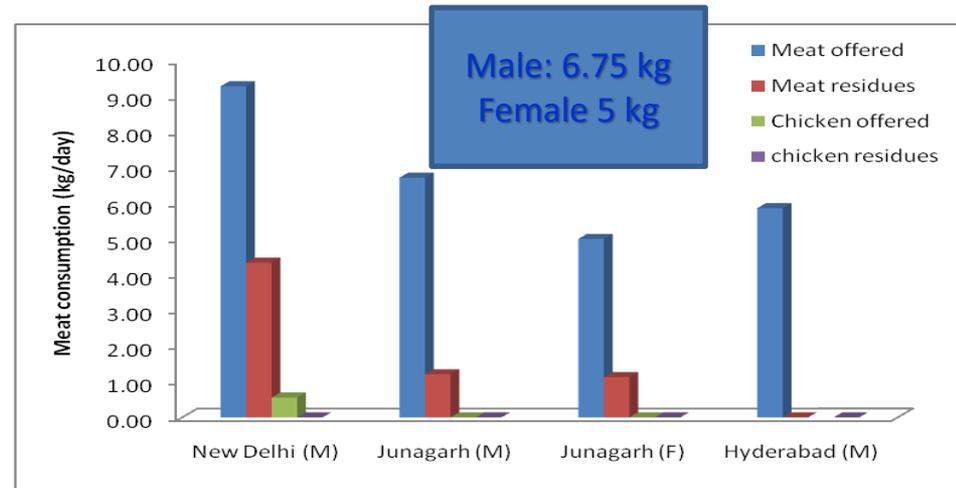
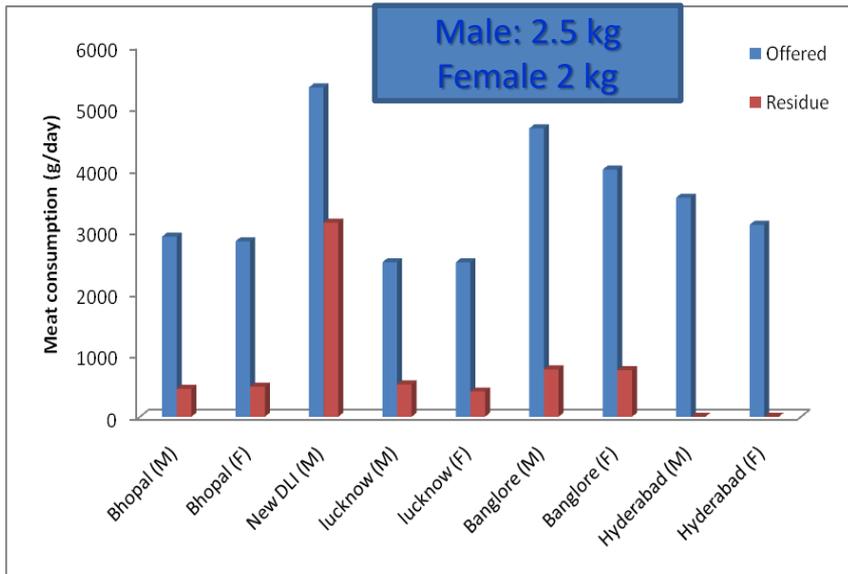
## DE ( Kcal) intake in tigers

Zoo		Per day	Per BW <sup>0.75</sup>
Hyderabad	Male	11860	201
	Female	11410	280
Bangalore	Male	26409	447
	Female	18394	452
Bhopal	Male	13644	231
	Female	10601	260
Nandankanan	Male	13293	225
	Female	11650	286

## Feed consumption and refusals by tigers in different zoos



## Feed consumption and refusals by leopards and Asiatic lions in different zoos



### Meat offered and refusals in Asiatic lions at different zoos

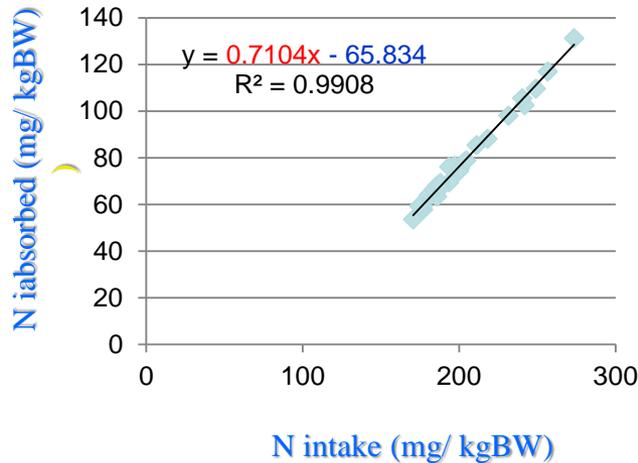
### Meat offered and refusals in leopard at different zoos

## Suggested guidelines for feeding Amount of meat-on- bone ( kg/d) to be fed

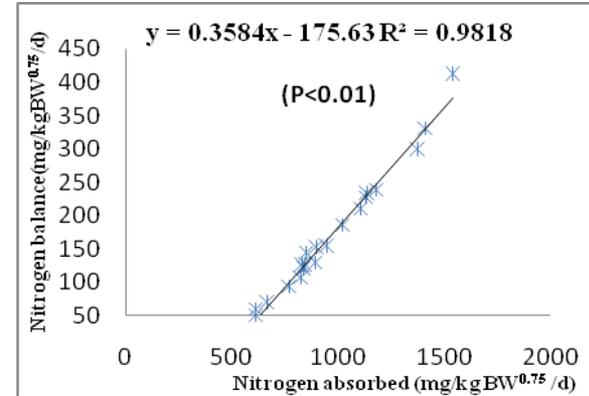
Species	Male	Female
Tiger	8	6
Lion	6.75	5
Common leopard	2.5	2
Snow leopard	2.5-3.0	2.0-2.5
Clouded leopard	0.75-1.5	

- **Boneless meat must be supplemented with 7-10 g of Ca/kg meat.**
- **Vitamin fortification should be done to provide 9000 IU of vitamin A and 500 IU of Vitamin D per kg of meat on dry matter basis. Simplifying it, we can add 3000 IU of vitamin A and 150 IU of vitamin D to every kg of fresh meat.**
- **Some zoo fed liver, egg and milk as a supplement to their tiger diet. Such practices should be reassessed. It is better to use commercial vitamin supplement.**
- **Further behavioral enrichment could be provided by innovative thoughts applicable at local level.**

# Estimating protein requirements of zoo animals



true protein digestibility= 0.71  
MFN=65.8 mg/kg BW



Efficiency of utilization= .036  
EUN= 176 mg mg/kg BW 0.75

Minimum CP requirement can be calculated as per the model of Robbins *et al.* (1993)

CP % in diet =  $\{ [EUN + \text{dermal loss}) + MFN (DMI) * 6.25] / DMI / TPD \} * 100$ .

Where, EUN: endogenous urinary nitrogen; MFN: metabolic faecal nitrogen; TPD, true protein digestibility

MFN can also be estimated as the fraction of fecal N that is soluble in neutral detergent solution

## Intake and utilization of N in Indian rhinoceros fed three season specific diets

Parameters	Sugarcane	Berseem	Jowar
N intake (g/d)	208.23±22.27	361.04±40.26	262.95±30.98
MFN (g/d)	86.89±10.6	117.6±12.5	96.93±10.3
EUN (g/d)	35.6±3.10	35.77±3.11	35.97±3.04
Total endogenous loss	122.5±13.70	153.3±15.57	132.91±13.25
CP % Diet	5.51 <sup>a</sup> ±.10	6.44 <sup>b</sup> ±.06	5.54 <sup>a</sup> ±0.08

Kumar, 2012

- NRC (1989) recommends 8% CP for maintenance of adult horse
- NAG (1997) recommends 10-12 % CP for maintenance of adult white rhinoceros

## Intake and utilization of N in Asian elephants

Parameters	Dietary treatments		
	Group-I	Group-II	Group-III
N-intake (g/d)	617±79.1	631±27.2	624±27.4
N in faeces (g/d)	396±23.3	390±22.5	391±23.1
MFN (g/d)	269±14.6	274±14.6	275±14.4
EUN (g/d)	60.7±3.43	60.7±3.44	60.6±3.43
Dermal losses (g/d)	14.8±0.83	14.8±0.84	14.73±0.83
Total endogenous loss (g/d)	344±18.8	349±18.9	350±18.4
True Protein Digestibility (%)	80.4±0.88	81.9±1.11	81.7±1.30
<b>Minimum CP (% in diet)</b>	<b>5.8±0.09</b>	<b>5.9 ±0.09</b>	<b>6.0 ±0.14</b>

† All the elephants were allowed to forage for 6 h/ d and were fed cut branches of Rohini tree ad lib. However, the amount of WR fed to the elephants in groups I, II, and III was 0.18, 0.12 and 0.06% of BW, respectively.

Das et al., 2014

**NAG (1997) recommends 8 -10% CP for maintenance of adult Asian elephant**

## Intake and utilization of N in Blackbuck

Parameter	Groups†		
	I	II	III
N intake* (g/day)	8.27 <sup>a</sup> ± 0.25	12.27 <sup>b</sup> ± 0.30	16.42 <sup>c</sup> ± 0.36
N in faeces (g/day)	5.67 ± 0.24	6.27 ± 0.20	6.21 ± 0.12
MFN (g/day)	5.55 ± 0.22	5.86 ± 0.19	5.57 ± 0.11
EUN (g/day)	1.75 ± 0.06	1.71 ± 0.05	1.79 ± 0.05
Minimum CP (% diet)	8.28 ± 0.11	8.72 ± 0.23	8.27 ± 0.17

Overall, CP content of the diets was 6.9%, 10.4% and 12.7% i  
respectively.

Das et al., 2012

NAG (1997) recommends 14-17% CP for medium intermediate grazers

Should we relook into the earlier recommendations or we wait for  
further research data ??

## CP content of diets fed to Indian Rhinoceros as compared to minimum CP content of diets required for maintenance

Zoo	CP% in diet	Requirement
Kanpur	9.73	8.1*
		5.8 **
Assam	9.96	
Patna	9.32	

\* NRC(1989) requirement for horses

\*\* Estimated requirement for Indian rhinoceros from the present study

CP % in diet	Roughage source		
	Sugarcane	Berseem	Jowar
	7.15	11.53	8.33

Protein supply is dependent on season specific forage source

## Intake and utilization of N is also influenced by age

<b>Intake and utilization of N (mg/ Kg BW<sup>0.75</sup>/ d) in Asian elephants</b>			
	<b>Calf</b>	<b>Sub-adult</b>	<b>Adult</b>
Intake	2466 <sup>c</sup> ±92.1	2249 <sup>b</sup> ±33.5	1675 <sup>a</sup> ±77.5
Absorbed	1443 <sup>c</sup> ±48.9	1138 <sup>b</sup> ±15.5	812 <sup>a</sup> ±50.3
Balance	347.1 <sup>c</sup> ±33.4	227.5 <sup>b</sup> ±6.0	123.1 <sup>a</sup> ±18.9
MFN losses	714.5 <sup>c</sup> ±98.1	627.2 <sup>b</sup> ±19.8	417.8 <sup>a</sup> ±30.2
EUN losses	219.0 <sup>c</sup> ±0.0	189.2 <sup>bA</sup> ±0.9	153.0 <sup>aA</sup> ±0.0
Dermal losses	35.0±0.0	35.0±0.0	35.0±0.0
Total endogenous losses	969 <sup>c</sup> ±98.1	851.4 <sup>b</sup> ±20.1	605.8 <sup>a</sup> ±30.2
True digestibility (%)	82.0 <sup>c</sup> ±3.8	74.25 <sup>b</sup> ±1.4	75.8 <sup>a</sup> ±0.9
<b>Minimum CP%*</b>	<b>9.7<sup>a</sup> ±0.6</b>	<b>8.0<sup>b</sup> ±0.2</b>	<b>6.0<sup>c</sup>±0.0</b>
<b>CP% (NAG, 1997)</b>	<b>12-14</b>	<b>12-14</b>	<b>8-10</b>

Are captive Asian elephant diets adequate in CP content ????

	<b>Guwahati</b>	<b>Chattbir</b>	<b>Hyderabad</b>	<b>Mysore</b>
CP (%)	7.89±0.16	<b>9.73±0.01</b>	8.01±0.13	<b>10.82±0.17</b>

## Ration adequacy with respect to crude protein supply

Species	Suggested CP%	CP % in the diet being fed
Cervids	12-16	13.0-18.5
Antelopes	8-10	14.5-18.8
Wild ass	8	12.2
Rhinoceros	8	9.3-9.7
Adult elephant	8	7.9-10.8
Growing elephants	12	11.0-11.4
Giant squirrel	15	15.2- 16.1
Monkeys	8	12.0- 21.6% (LTM)
Langurs	17	14.1- 21.5

# Are we obsessed with feeding excessive protein to our zoo animals

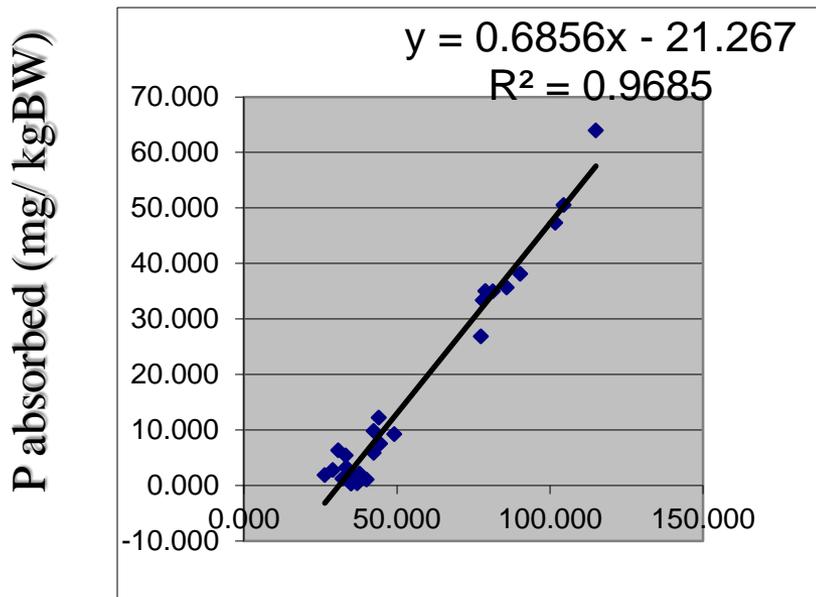
Das et al., 2013b

Species	Suggested CP%	CP% of the diet being fed
Slow loris	17	13
Tibetan wolf	28	57.4- 66.4
Bear	15	14.7-17,7
Red Panda	18	13.7 -16.5
Pelican	20-30	74.1-75.6
Psticines	10-15	12.6-14.7
Hornbill	11	7.2-32.2 ????????

Barring growing elephants, some langurs and red panda, zoo animals are generally burdened with excessive proteins

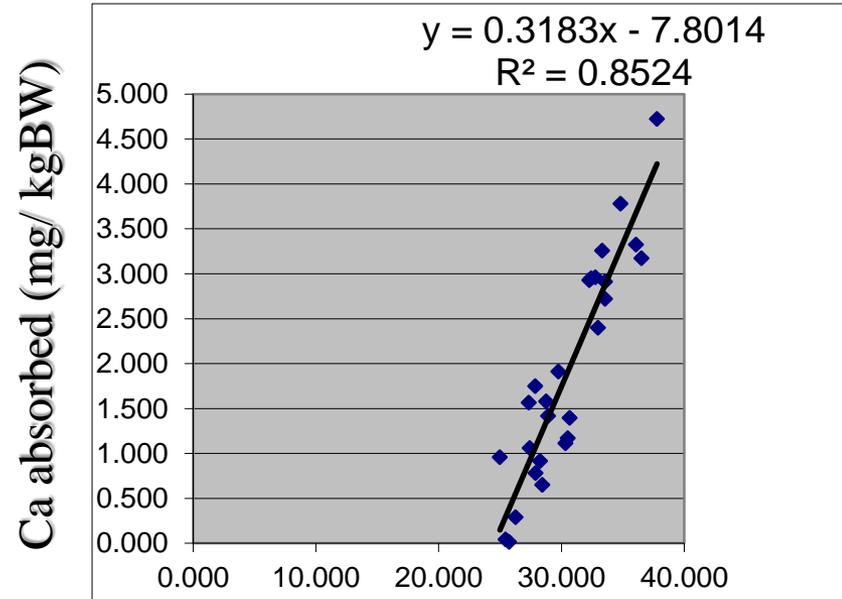
# Understanding the mineral requirement of zoo animal

## Correlation between intake (mg/ kg BW) and absorption (mg/kg BW) of Ca and P in Indian rhinoceros fed conventional zoo diets



Ca intake (mg/kg BW)

0.26%



P intake (mg/kgBW)

0.20%

Kumar, 2012

## A comparison of the estimated mineral requirements

	Asian elephant		Indian rhinoceros	
	NAG (1997)*	Our estimate	NAG (1997)**	Our estimate
Ca (%DM)	0.30	0.23	0.55-0.63	0.26
P (%DM)	0.20	0.18	0.32-0.38	0.20
Fe (mg/ kg DM)	50	41	73-84	40
Cu (mg/ kg DM)	10	6.9	8-14	7.1
Zn(mg/ kg DM)	50	29.7	41-71	34.4

\* Nutrition Advisory Group (NAG) recommendations for Elephants

\*\* Nutrition Advisory Group (NAG) recommendations for white rhinoceros

## Ration adequacy with respect to Cu and Zn supply

Species	Zn requirement (ppm)	Zn content of diet (ppm)	Zn requirement (ppm)	Zn requirement (ppm)
Cervids	40	32-42	10	7.8-9.9
Antelopes	40	23-32	10	8-9.7
Wild ass	50	28.9	10	9
Rhinoceros	41-71	27.4-35.5	8-14	6.6-10.6
Adult elephant	50	20.9-30.5	41-71	8.3-11.2

Deficiency of Zn and Cu was widespread among captive herbivores

## Conclusions

- Basic data on feed consumption, diet digestibility and utilization of macro and micro nutrients in 53 selected species is generated. Major problems identified were excessive intake of calorie, protein and deficiency of Cu and Zn in many species.
- Nutritional adequacies of diet schedules followed by different zoos have been evaluated and specific measures for improvement have been suggested.
- For further improvement, role of nutrients in improving gut health, antioxidant, immunity , reproduction and welfare of captive animals should be explored.



**Thanks for kind attention!**