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Utilization of *Blepharis sindica* herbage in sheep feeding: Effect on nutrient utilization, rumen fermentation and plane of nutrition

R S BHATT[1], A SAHOO[2], LALIT KUMAR SONI[3] and S K SANKHYAN[4]

ICAR-Central Sheep and Wool Research Institute, Avikanagar, Rajasthan 304 501 India

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Lack of adequate year-round feed resources is probably the most important factor causing to low animal production in arid and semiarid regions. Under such situation there is need to utilize local forage and pasture species and ecotypes, which have developed characters to cope the drought and to develop appropriate strategies for better use of these feed resources in livestock feeding. *Blepharis sindica* T. Anders is well adapted to sandy soils and increases nutrient use efficiency with declining soil resources (Mathur 2013). Plant grows luxuriantly from January to March when there is shortage of grazing resources, but due to spine growth on leaf and small stems sheep and goat find it difficult to graze and farmers after harvesting, press it, under the moving vehicles to break the spines before feeding to buffaloes. Therefore *Blepharis sindica* plants after harvesting, chaffed, dried in shade and added in complete feed blocks for adult sheep to study the feeding value.

The experiment was conducted at the CSWRI, Avikanagar (Rajasthan, India). Adult rams (36) of Malpura breed were divided randomly into 3 groups of 12 each and were fed *ad lib.* complete feed block and water round the clock. The rams were housed individually in well ventilated sheds, which was covered on all sides with brick wall, asbestos sheet roofing and mud flooring. During morning (6.00–8.00 h) and evening (17.00–19.00 h) time rams were kept in open coral outside the shed. Composition of complete feed block in all the groups is given in Table 1. Feed blocks were offered *ad lib.* to individual animals and daily recording of intake and residue left over were maintained during the experimental period of 60 days. Metabolizable energy intake (MEI) was calculated according to AAC (1990).Live weight was recorded at weekly interval in the morning before watering of the experimental rams. Samples of feed block from each treatment were collected once in a week, respective samples were pooled after drying for chemical analysis. A metabolic trial for 10 days with 4 days as adaptation period and 6 days collection period was conducted after 42 d of experimental feeding on 5 representative rams from each group. The samples of feed and feces were dried in forced air oven at 70°C till constant weight for dry matter determination. Samples were ground to pass a 1 mm screen and preserved for chemical analysis. Daily fresh samples of feces were preserved with 1:4 sulphuric acid for N assay. Similarly, aliquots of urine were preserved for estimation of N. Urine excreted was collected in a container consisting of 100 ml 10% sulphuric acid and after recording urine was diluted with water to one litre. Urine sample (20 ml) was stored at – 20.0°C for purine derivatives analysis by the method of (IAEA 1997).

Rumen liquor samples (50 ml) were drawn during

Table 1. Composition of feed block and *Blepharis sindica* hay

Feed Ingredients	Block-I	Block-II	Block-III	*Blepharis sindica* herbage
Physical composition (kg/100kg)				
Maize	15.7	15.7	15.7	
Barley	15.7	15.7	15.7	
Groundnut cake	1.4	1.4	1.4	
Mustard cake	1.0	1.0	1.0	
Cenchrus hay	60	30	15	
Blepharis sindica herbage	-	30	45	
Mineral mixture	1.0	1.0	1.0	
Salt	0.2	0.2	0.2	
Molasses	5	5	5	
Chemical composition (% on dry matter basis)				
Dry matter	95.08	94.87	95.18	28.93
Organic matter	90.79	90.97	89.34	94.31
Total ash	9.09	9.64	9.03	5.69
Acid insoluble ash	2.51	2.49	2.47	1.91
Crude protein	10.32	10.66	11.14	7.71
Neutral detergent fibre	69.68	67.66	64.72	64.23
Acid detergent fibre	47.49	43.74	42.74	41.02
Hemicellulose	22.19	23.39	22.67	23.21
Cellulose	39.98	32.91	30.98	25.55
Lignin	7.51	8.35	9.07	15.17

Present address: [1-4] Principal Scientist (bhatt_rs @yahoo.com,sahooarta1@gmail.com, sonilalit91@gmail.com, sankhyan1964@yahoo.com), Division of Animal Nutrition.

morning before feeding from all the rams using a stomach tube connected to a suction pump. Each sample was placed in a 100 ml glass jar and the pH was determined using a digital pH meter within 4–5 min of sampling. After pH determination, rumen fluid was strained with 4 layers of muslin cloth and strained rumen liquor (SRL) sample were preserved by adding a few drops of saturated mercuric chloride solution and kept in labelled polypropylene bottles at –20°C temperature. Samples were analyzed for total nitrogen (micro Kjeldahl) and ammonia nitrogen. Volatile fatty acids were estimated by using gas chromatography. For protozoa count, 1 ml of SRL was taken using a wide orifice pipette and 1 ml of formalinized physiological saline was added into a scintillation vial. Thereafter 2 drops of brilliant green dye was added, mixed and allowed to stand at room temperature. Total and differential counts of protozoa were made in 20 microscopic fields in a haemocytometer counting chamber at a magnification of 100X. The moisture, CP, ether extract and ash content of feed, feces, urine and meat samples were determined by methods of AOAC (1995). Fiber fractions were determined as per Robertson and Van Soest (1981). Hemicellulose was calculated as difference between NDF and ADF. Cellulose was calculated as difference between the ADF and ADL content of the sample. Data on body weight, plane of nutrition and digestibility of nutrients and rumen fermentation were subjected to one way analysis of variance using Duncan test using SPSS Base 14.

Feed blocks were prepared by incorporating dry chaffed *Blepharis sindica* herbage at 0, 30 and 45% as a partial (0, 50 and 75%) replacement of cenchurus hay (Table 1). *Blepharis sindica* roughage consisted of 7.71% crude protein which is higher than that in cenchurus hay and as a result the protein content was slightly increased with its incorporation in Block-2 and Block-3. In comparison to 7.71% crude protein in *Blepharis sindica* herbage, Mathur *et al.* (1988) reported higher crude protein in shoot of the plant. This variation may be due to the change in harvesting stage as the plants harvested for this experiment were fully mature. Fibre fractions revealed it as a good source of hemicelluloses and cellulose with slightly higher lignin content (Table 1). The Feed blocks contained an average of 10.3 to 11.1% CP which is considered enough for maintenance of adult rams (ICAR 2013).

Significant (P<0.05) differences were observed in the digestibility of dry matter, organic matter, crude protein, acid detergent fibre and cellulose among different treatment (Table 2). Digestibility of dry matter, organic matter and crude protein was increased (P<0.05) with incorporation of *Blepharis sindica* herbage whereas that of ADF and cellulose was lowered (P<0.05) and no effect was observed on the digestibility of NDF and hemicelluloses. This may be due to lower fibre fractions and slightly higher CP content in *Blepharis sindica* herbage which increased the CP content and lowered the fibre content of test diet. Fibre fraction, i.e. NDF, ADF and lignin are negatively correlated with

Table 2. Digestibility (%) and intake of nutrients (g/day) during metabolic trial in animals fed different experimental diets

Parameter	Block-1	Block-2	Block-3	SEM	Significance
Digestibility					
Dry matter	50.82^{a}	55.11^{b}	54.13^{b}	1.073	0.043
Organic matter	54.29^{a}	60.52^{b}	58.25^{b}	1.023	0.017
Crude protein	46.21^{a}	57.51^{b}	55.26^{b}	2.259	<0.001
Neutral detergent fibre	47.94	46.31	46.06	1.251	0.421
Acid detergent fibre	44.17^{b}	41.70^{b}	35.69^{a}	1.417	0.031
Hemicellulose	55.79	49.46	51.67	2.637	0.145
Cellulose	52.80^{b}	49.49^{a}	46.67^{a}	1.203	0.006
Nutrient intake (g/d)					
Dry matter	1320.9^{c}	1010.0^{a}	1079.5^{b}	48.661	0.005
Organic matter	1194.8^{c}	922.54^{a}	965.1^{b}	43.817	0.006
Crude protein	98.3^{c}	79.1^{a}	89.8^{b}	3.268	<0.001
Neutral detergent fibre	908.9^{c}	591.4^{a}	655.5^{b}	41.31	<0.001
Acid detergent fibre	614.6^{b}	433.5^{a}	444.9^{a}	26.53	<0.001
Cellulose	520.0^{b}	350.3^{a}	371.9^{a}	15.39	<0.001
Hemicellulose	294.3^{c}	157.5^{a}	210.6^{b}	23.26	<0.001
Nitrogen balance					
Nitrogen intake (g/d)	22.93^{c}	17.80^{a}	20.17^{b}	0.522	0.017
Faecal excretion (g/d)	12.36^{c}	7.61^{a}	9.00^{b}	0.605	0.071
Urinary excretion (g/d)	5.52^{a}	6.00^{b}	6.54^{b}	0.260	0.022
Absorbed (g/d)	10.57^{a}	10.19^{a}	11.17^{b}	0.242	0.008
Balance (g/d)	7.68	6.78	7.68	0.184	0.299
Balance (% of intake)	46.09^{a}	57.24^{b}	55.37^{b}	0.135	0.019
Balance (% of absorbed)	72.65^{b}	66.53^{a}	68.75^{a}	0.112	0.012

SEM, standard error of mean; values bearing different superscripts in a row differ significantly (P<0.05).

digestibility and crude protein content of herbages tends to be positively associated with digestibility which is in agreement to the results of our experiment. The improvement in CP digestibility found in this study was due to the supply of adequate nitrogen that was required for maximum microbial growth and multiplication. The supplementation of *Blepharis sindica* hay to cenchurus grass-based diet increased the CP content of diets to overcome a ruminal deficiency and to provide fermentable fiber (Abdou *et al*. 2011), so that rumen microbes can have access to more protein, energy, and minerals for their multiplication (Belanche *et al*. 2012). Dry matter intake was lowered (P<0.05) during metabolic trial in Block-2 and Block-3 diet and as a result the intake of OM, CP, NDF, ADF, hemicelluloses and cellulose was reduced in these diets compared to control (Block-1). Intake of nitrogen and its excretion through faeces and urine was lower (P<0.05) in block-2 and block-3 diet compared to block-I however similar balance of nitrogen (g/d) was observed among all the groups. The dry matter intake during metabolic trial followed the similar trend as was followed during the feeding trial except in block-2 fed rams where dry matter intake was lower to that of block-3 fed rams during metabolic trial. This variation may be due to selection of few animals and short feeding period during metabolic trial as compared to that during the feeding trial. Due to this reason the intake of OM, CP, NDF, ADF, hemicellulose and cellulose was lower in block-2 fed rams compared to that in block-3 fed rams. Balance of nitrogen when expressed as% of intake and absorbed was higher (P<0.05) in block-2 and block-3 fed rams as compared to those fed control blocks. Higher balance of nitrogen with *Blepharis sindica* herbage incorporation is reflection of better protein quality in this herbage than the cenchurus hay. An increase in efficiency of nitrogen utilization in *Blepharis sindica* supplemented diets might be associated with the larger proportion of rumen degradable protein.

Rumen metabolites revealed higher (P<0.05) values of total nitrogen, TCA precipitable nitrogen and ammonia concentration in rumen liqueur of rams fed block-2 and block-3 diet compared to block-1 however TVFA values were lowered in rumen liqueur of rams fed block-3 and block-2 compared to block-1 fed rams (Table 3). Increased nitrogen contents and rumen ammonia in rumen liqueur of block-2 and block-3 fed rams is due to higher nitrogen in these feed blocks. Higher value of TCA-ppt-N in test groups is indicating higher value of true protein in these groups. Production of acetic, propionic and butyric acid was lowered (P<0.05) with the incorporation of *Blepharis sindica* in block-2 and block-3 compared to block-1 fed ram. No difference was observed on the proportion of individual VFA among different treatment. Volatile fatty acids production was lowered in *Blepharis sindica* herbage supplemented diets and similar trend was also observed for individual fatty acid level. Exact reason for this drop is not known however this herbage is rich in phytochemicals including flavonoides (Apurva *et al.* 2015) which is reported to have depressing effect on VFA production (Oskoueian *et al.* 2013). More than 85% of the digestible fibre and 90% of the total soluble carbohydrate are digested in the rumen

Table 3. Rumen metabolite of animals fed different experimental diets

Parameter	Diet			SEM	Significance
	Block-1	Block-2	Block-3		
SRL pH	6.44	6.30	6.52	0.037	0.436
Total nitrogen (mg/100 ml SRL)	48.50 [a]	52.21 [a]	66.73 [b]	4.051	0.025
TCA-ppt-N (mg/100 ml SRL)	37.96 [a]	41.80 [a]	51.52 [b]	4.002	0.003
NH_3-N (mg/100 ml SRL)	5.47 [a]	5.99 [a b]	6.88 [b]	0.226	0.006
Total volatile fatty acids (meq/L)	48.71 [b]	41.51 [b]	24.81 [a]	4.068	0.037
Volatile fatty acids (m mole/ 100 ml SRL)					
Acetic	34.90 [b]	29.61 [b]	18.45 [a]	2.821	0.041
Propionic	8.12 [b]	6.51 [b]	3.75 [a]	0.700	0.024
Butyric	5.36 [b]	5.03 [b]	2.40 [a]	0.528	0.040
Valeric	0.33	0.36	0.23	0.022	0.147
Propionic acid/TVFA	0.17	0.15	0.15	0.003	0.124
Propionic /(acetic+butyric)	0.20	0.18	0.18	0.005	0.137
Proportion (%) of individual VFA					
Acetic	71.72	72.05	74.58	0.788	0.284
Propionic	16.78	15.50	14.98	0.371	0.124
Butyric	10.42	11.22	9.18	0.464	0.205
Protozoa population (× 10^4 ml SRL)					
Holotrichs	27.3	24.5	22.2	2.757	0.775
Spirotrichs	168.3	170.1	156.2	11.240	0.272
Total	193.0	193.5	173.3	11.864	0.229

SEM, standard error of mean; TVFA, total volatile fatty acids; values bearing different superscripts in a row differ significantly (P<0.05).

and digestible fibre leaving the rumen is digested by fermentation in the terminal ileum and ceacum thereby not affecting the overall digestibility of fibre even if VFA production is lowered. No effect on the proportions of individual fatty acids on the population of protozoa in different diets is a reflection that the feed blocks were free of principles detrimental for microbial growth.

The intake of digestible organic matter was significantly (P<0.05) lower in block-2 and block-3 fed rams which is due to higher nitrogen supplied from these diets required for maximum microbial protein synthesis. Microbial protein synthesis per kg of DOMI was significantly (P<0.05) higher in block-2 and block-3 fed rams however no difference was observed on the excretion of purine derivatives through urine in rams fed different types of feed block (Table 4). In animal production systems, the best way to increase voluntary intake and digestibility of poor quality forages is to increase the number and/or activity of ruminal microbes in order to maximize fiber digestion and improve microbial protein synthesis (Belanche *et al.* 2012). The supplementation of *Blepharis sindica* hay to cenchrus hay based diet was mainly carried out to increase the CP content of diets in order to overcome a ruminal deficiency and to provide fermentable fiber (Abdou *et al.* 2011), so that rumen microbes can have access to more protein, energy, and minerals for their multiplication (Belanche *et al.* 2012).

No difference on initial weight, final weight, daily weight change in rams (Table 5) fed different feed blocks was observed (P<0.05). Plane of nutrition revealed lower (P<0.05) daily dry matter intake in rams fed block-3 and block-2 compared to block-1 fed ram. It is due to inclusion of unconventional feedstuff in the diet however significantly (P<0.05) higher digestibility of nutrients (DM,OM and CP) could support enough supply of energy and protein for maintaining the adult rams. Daily organic matter intake was also lower in these rams compared to those fed control feed block. Similar body weight of rams by feeding less amount of *Blepharis sindica* herbage incorporated feed blocks is indicating that this herbage after processing can be used in the feeding system up to 45% . Daily dry matter intake of rams was in the range of 2.2–2.5% of their body weight which is sufficient to take care of their maintenance needs.

Table 4. Excretion of purine derivatives (PD) and microbial nitrogen synthesis in animals fed different experimental diets

Parameter	Block-1	Block-2	Block-3	SEM	Significance
Body weight (kg)	51.24	50.68	51.27	1.627	0.988
Excretion of purine derives (m mole/L)					
Allantoin	4.46	3.96	4.12	0.160	0.455
Xanthine+hypoxanthine	0.32	0.38	0.38	0.029	0.672
Uric acid	0.89	0.92	0.82	0.036	0.557
Total PD excretion	5.67	5.27	5.32	0.172	0.609
PD absorption	5.96	5.37	5.42	0.255	0.604
Microbial N synthesis (g)/day	4.03	3.90	3.94	0.185	0.604
Digestible organic matter intake (g/day)	651.8^{b}	531.7^{a}	562.7^{a}	27.80	0.013
Microbial N (g)/kg DOMI	6.18^{a}	7.68^{b}	7.0^{ab}	0.129	0.026
MCP/100g DOMI	3.86^{a}	4.80^{b}	4.38^{ab}	0.168	0.026

SEM, standard error of mean; DOMI, digestible organic matter intake; MCP, microbial crude protein; values bearing different superscripts in a row differ significantly (P<0.05).

Table 5. Body weight change and plane of nutrition in animals fed different experimental diets

Parameter	Block-1	Block-2	Block-3	SEM	Significance
Initial weight (kg)	49.3	49.5	49.4	1.731	0.978
Final weight (kg)	51.0	50.7	51.2	1.645	0.990
Weight change (kg)	1.7	1.2	1.8	0.309	0.673
Weight change/day (g)	48.2	34.3	51.4	0.309	0.673
Plane of nutrition (g/d)					
Dry matter intake	1255.3^{b}	1184.0^{ab}	1103.7^{a}	22.80	0.014
Organic matter intake	1139.7^{b}	$1077.1^{a\,b}$	986.1^{a}	21.68	0.006
Crude protein intake	129.5	123.0	123.0	1.39	0.845
Digestible crude protein intake (g/d)	59.8^{a}	70.7^{b}	67.9^{b}	1.67	<0.001
ME intake (MJ)	9.3	9.4	8.6	0.16	0.070
DCPI (g)/MJ	6.43^{a}	7.52^{b}	7.89^{b}	0.17	0.029

Value bearing different superscripts in a row differ significantly (P<0.05).

DM intake is an important factor to determine energy intake and performance in ruminants and feed supplements in general should not adversely affect intake of roughage. Intake of digestible crude protein was higher in block-2 and block-3 fed rams compared to those fed block-1and no effect on intake of ME was observed in different treatments. As a result the ratio of digestible crude protein intake to that of ME was higher ($P<0.05$) in block-3 and block-2 compared to those fed block-1 rams. Although digestible crude protein intake was lower in control group as compared to test group however both protein and energy intake was sufficient to take care of the maintenance needs of adult ram (ICAR 2013). Increased microbial protein synthesis in block-2 and block-3 diet is also substantiated with higher P/E ratio in these diets. Since anaerobic fermentation in the rumen provides microbial cells which supply the protein to the animal, the efficiency of microbial growth therefore influences the P/E ratio. Poor microbial growth due to inadequate dietary N will result in low P/E ratio and conversely adequate supplementation and good rumen function enables a good P/E in the nutrients available to the animal. Intake is shown to be more sensitive to P/E ratios rather than to VFA proportions which is also true in this experiment.

From this experiment it is concluded that *Blepharis sindica* herbage can be used as a feed resource in arid and semi arid region up to 45% in complete feeding system of small ruminants after chaffing and pressing having better nutrient utilization, higher plane of nutrition and higher microbial protein synthesis.

SUMMARY

Rams (36) were fed *ad lib.* complete feed block (CFB) in 3 groups up to 60 days. Block-1 consisted 35, 60 and 5% of concentrate, cenchrus hay and molasses respectively. In block-2 and block-3 *Blepharis sindica* herbage was added at 30 and 45%. Dry matter, organic matter, crude protein digestibility increased whereas ADF, cellulose decreased with *Blepharis sindica* incorporation. Nitrogen balance was higher in block-2 and block-3 fed rams. Total nitrogen, TCA precipitable nitrogen, ammonia level was higher and TVFA lower in SRL of rams fed block-3 and block-2. Microbial protein synthesis / kg of DOMI was higher and dry matter intake was lower in block-2 and block-3 fed rams. Due to better nutrient utilization, higher plane of nutrition and microbial protein synthesis *Blepharis sindica* herbage can be used in sheep feeding up to 45% after processing as CFB.

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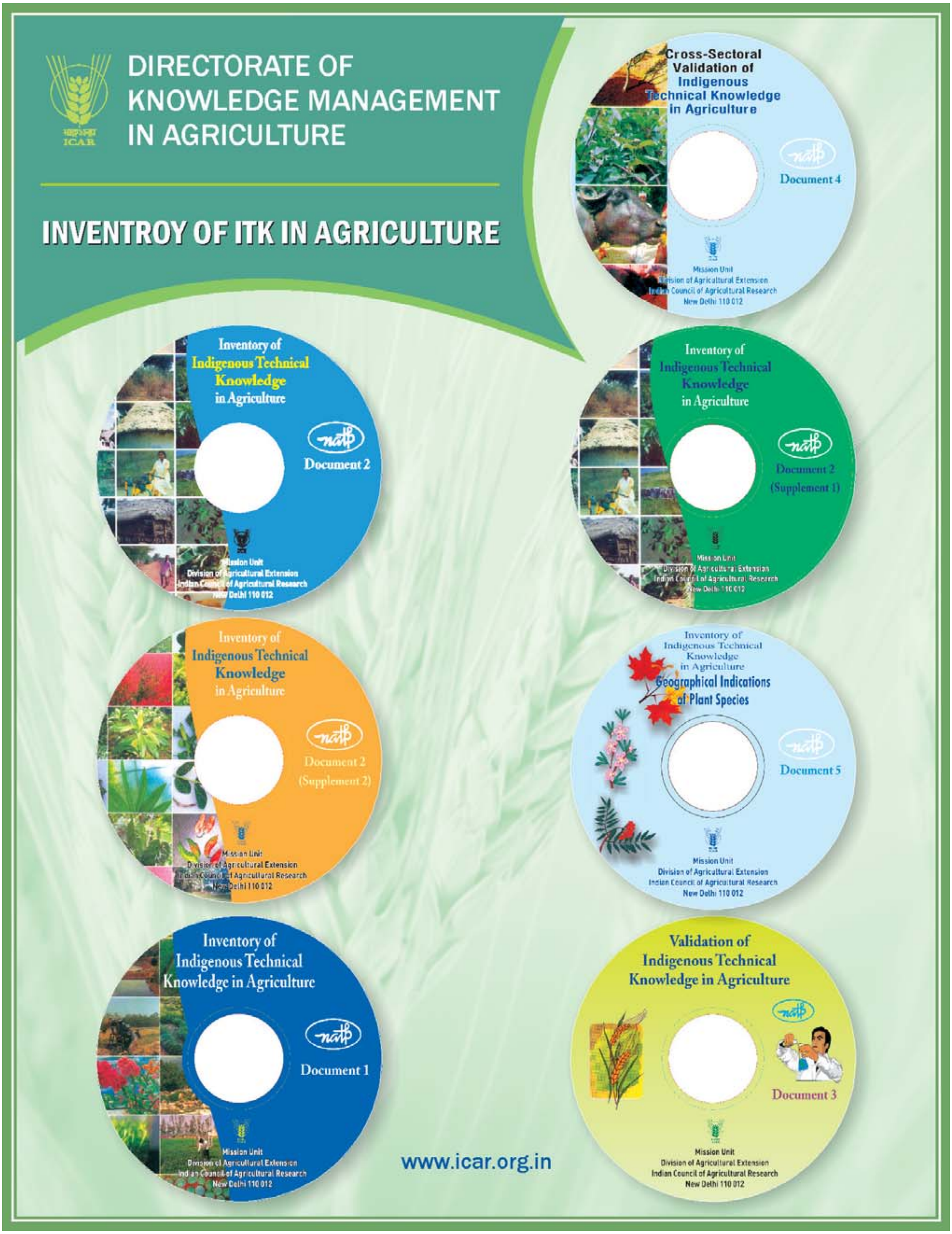
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