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On-Station Nutritive Assessment of Feed-Block and Feed-Back of Its On-Farm Acceptance by Small Ruminant Farmers in Iwo Local Government Area of Osun State, Nigeria

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Abstract:
Animal production in Nigeria, particularly Small Ruminant (SR) animals are largely dominated by traditional livestock keepers who do not have direct access to information on research output. Also, SRs are faced with the challenge of adequate and quality forage availability in dry season. However, in wet season, forages are available in quantity and quality, hence; they can be stored as feed-bank for later use in dearth periods. Information on the use of feed-block for SR production in Osun state, Nigeria is not well documented. Three feed-blocks: Gliricidia-Based (GB), Cassava-Top Based (CTB) and GB/CTB mixture (ratio 3:4) were made on-station and the nutritive value determined (proximate composition and in-vitro fermentation) using standard procedures. The feed-blocks were introduced to SR farmers in the study area. Twenty interested resource persons keeping SRs in the area were sourced and on-farm demonstration of feed-block making was done. Feed-back was evaluated using a structured questionnaire to assess acceptability and constraints in making feed-blocks. Data were analysed using descriptive statistics and ANOVA at p = 0.05. It was found that the crude protein of the feed blocks ranged from 15.3 to 20.1% (CTB and GB/CTB). In-vitro fermentation analyses showed organic matter digestibility of 37.1 (CTB) and 50.3% (GB/CTB) while the degradability: 53.1% (GB) and 66.4% (GB/CTB). Sixty-one percent of the resource persons produced feed-blocks of which 63.6% indicated insufficient time for feed-block production as the major constraint to its practice. Adoption of feed-block for small ruminant production in the area was high; however, it was constrained by time.

***Keywords**: Acceptability, adoption, chemical composition, dry season feed, feed conservation, in-vitro fermentation,*

1. Introduction

Agricultural research is carried out to develop new technologies for improved productivity, on-station. However, the technologies must be properly channeled to the end users through an on-farm research method. On-farm study is a research developed to meet a specific need and carried out within the farmers' environment, involving their participation. Therefore, on-farm study is inevitable for farm-based research to thrive and it possesses catalytic effect that hastens acceptance of innovation/technology. Animal production in Nigeria particularly ruminant animals are largely dominated by traditional livestock keepers who does not have direct access to information on research output. Hence, such research results end up on the shelves of researchers without its real implementation by practicing farmers.

Ruminants can utilize large quantities of coarse humanly inedible roughages such as corn straw, cob, bean husk, etc for production and reproduction (Esminger and Olentine, 1980). They are physiologically adapted to obtain their nutrients from grass and other forages that humans do not use directly. They convert this low quality and fibrous feedstuffs to meat and milk that are rich in protein, minerals, fat and vitamins. In spite of their ability to convert forages to useful material, low quality forages are of low nutritive value to these animals. Seasonal fluctuations influence the availability of these forages in quantity and quality which results into low productivity of animals. Dry season forages give rise to lignified and low nitrogen feed composition which leads to reduced digestibility, low voluntary intake, weight loss and sometimes death (Sansoucy, 1986; Capper *et al*., 1989). On the other hand, these forages are available in quality and quantity which can be conserved in the time of plenty to bridge the gap created by dry season.

Researchers have explored various methods of conserving the excess forages in rainy season, but there were some flaws associated with these interventions. Hay making is weather dependent, prohibitive, shatters, labour intensive, less nutritive and requires much space for storage. Silage is laborious, highly technical, requires specialized space for storage, and ingestion of silage by ruminant results in high ammonia concentration which is excreted (urine) thereby creating a negative environmental impact (Tamminga, 1992).

Feed-block development can be another way forward, it offers an attractive possibility because it is cheap, handy, easy to make and transport, not weather dependent, ensures slow release of its nutrients to the animal and reduces feed wastage (Onwuka, 1999). Feed-block making technology can conveniently fit into the smallholder ruminant production system in Nigeria (Onwuka and Olatunji, 1996). Feed-blocks can be made through the use of predominant seemingly useless agro industrial by-products, agricultural by-products and browse plants using cement, slaked lime, gypsum, molasses or cassava starch as binder. Taiwo *et al.* (2005) in an on-farm study introduced cement bound feed-block as wet and dry seasons supplement to small ruminant farmers. However, they used wheat offal which is relatively expensive now. Rihawi (2005) also introduced feed-block made from tomato pulp wastes to Jordan farmers. In the study area, these industrial by-products are not accessible; however, there are cassava peel, cassava-top and *Gliricidia sepium* in large quantities which can be used to formulate feed-block on-farm.
Adoption of any improved technology involves a process in which awareness is created, attitudes are changed and favourable conditions for adoption are provided (Kuponiyi and Sodeinde, 2005). Adoption of technologies entails the decision to continue to use the technologies (Roger, 1995). Ghosh (2005) described the process of adoption as deciding and acting over a period of time. Therefore, properly designed extension services that disseminate research results to farmers and bring to the researchers their problems as a feedback are likely to yield higher socioeconomic returns and better quality research. The present study, therefore designed to examine the on-station nutritive value of feed-block and feed-back of its on-farm acceptance for small ruminant production in Iwo Local Government Area of Osun state, Nigeria.

2. Materials and Methods

The experiment is divided into two studies:

2.1. Study I: On-Station Assessment of Feed-Block for Ruminant Production

2.1.1. Study Site

The production of the on-station feed-block was carried out at the small ruminant unit, Teaching and Research Farm (TRF), University of Ibadan, Ibadan, Nigeria. It is located between longitude 3º54"E and 7º 30N and latitude 80N, the altitude is about 220m above sea level. The area lies on a transitional zone between the rain forest and the southern savannah. The annual rainfall ranges from 1150-1500mm with a mean temperature of 27^{o}C and mean annual rainfall of 1350mm. The chemical analysis and *in-vitro* fermentation were done at the Animal Science Laboratory, University of Ibadan.

2.1.2. On-Station Production of Feed-Block

The chopped forage was weighted into a big container; weighed cassava peel was added to the forage and mixed properly. Cassava starch that was cooked with hot water, applying heat, cooled to hand warm temperature was mixed with salt. The paste was then spread on the mixture of forage and cassava peel and mixed thoroughly with the hands as binder. The well mixed material was then placed in round plastic container. The material placed in the mould was pressed with the hand to ensure good compactness. A pressing pan was then placed on the feed-block in the mould and I stood on it for 5 minutes pressing it down. Thereafter, blocks formed in the containers were immediately removed (demoulded). The blocks were air dried for 2 days, hand turned over every day to ensure well dried blocks. The feed-block was sun dried to ensure good storage.

Feed material	GB	CTB	GB/CTB
Cassava peel	26.5	13.1	12.5
Cassava starch	17.0	17.0	17.0
Salt	0.5	0.5	0.5
Gliricidia sepium	56.0	-	40.0
Cassava top	-	69.4	30.0
Total	100.0	100.0	100.0

Table 1: Gross composition of on-station feed-block for small ruminant production

Where GB = Gliricidia-based feed-block, CTB = cassava-top based feed-block, GB/CTB = Gliricidia/cassava-top mixture feed-block
The feed-blocks were prepared to serve as dry season supplements. The average weight of feed-block produced with 4 litre paint container was 3.6kg. After drying, the average weight was around 1.25kg.

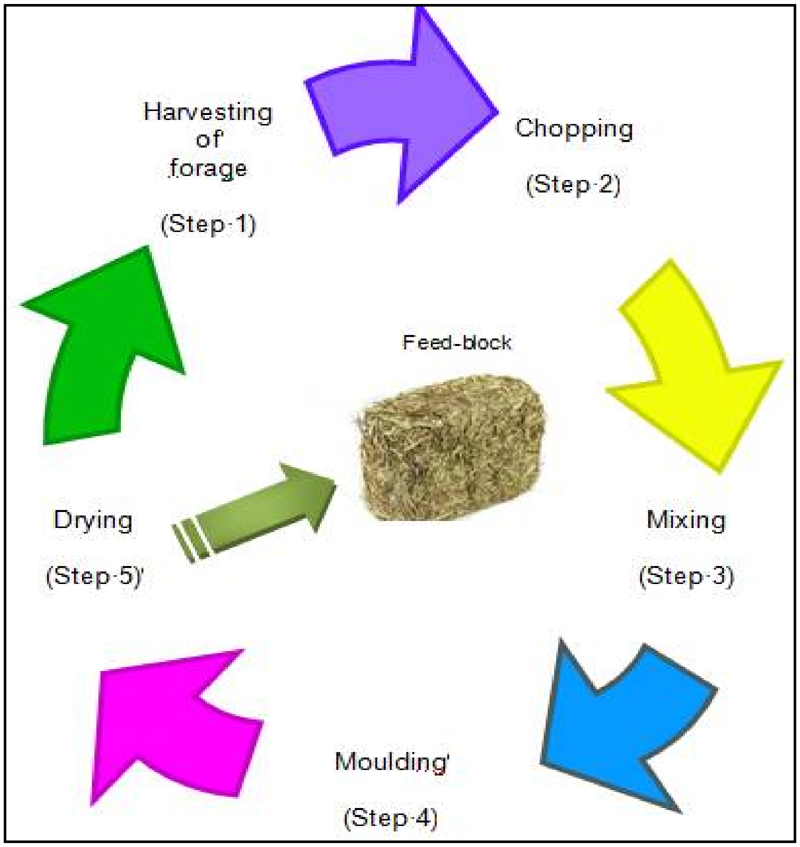

Figure 1: Schematic flow chart of Feed-block production
Source: Bamigboye, F.O

Presented in Table 1 and Figure 1 are the gross composition of the on-station feed-block and the schematic flow chart of feed-block making process respectively.

2.1.3. Proximate Analysis

The feed-blocks were weighed and oven dried at 105ºC to a constant weight (DM analysis. Crude protein, crude fibre, ether extract and ash contents of the sampled forages were determined according to AOAC (2000).

2.1.4. In-Vitro Gas Technique

Preparation of the buffer and rumen liquor was carried out as described by Menke and Steingass (1988). The substrate was placed in calibrated gas tight plastic syringes fitted with a piston. The syringes were put in an incubator at 39±1ºC. Rumen liquor was collected from three female West African Dwarf (WAD) goats, sieved with a four layered cheese cloth and mixed with a sodium buffer (9.8g $NaHCO_3$ + 2.77g $(Na)_2HPO_4$ + 0.57g KCl + 0.47gNaCl + 0.12$MgSO_4.7H_2O$ + $CaCl_2$. H_2O per 1000ml) in a ratio1:2 v/v. 200mg DM of each sample with 30ml of rumen liquor and buffer were placed in each syringe and incubated in triplicate under continuous flushing with CO_2. A blank (rumen liquor + buffer) without substrate was incubated at the same time. The reading of the blank was subtracted from that of the other syringes. Gas production was recorded at 3, 6, 9, 12, 15, 18, 21 and 24h. After 24h of incubation, 4ml of NaOH (10M) was introduced into inoculums as reported by Fievez *et al.* (2005) to estimate the amount of methane produced. The value of gas produced at intervals was plotted against the using the equation $Y= a + b (1-e^{ct})$ (Ørskov and Mc Donald, 1979), where Y= volume of gas produced at time t, a= initial gas produced, b= gas produced from insoluble but degradable fraction, c = the rate constant for the degradation of 'b' and t= incubation time.

2.1.5. Statistical Analysis

Data collected were subjected to analysis of variance at p=0.05.

2.2. Study II: Feed-Back of On-Farm Acceptance of Feed-Block for Small Ruminant Production

2.2.1. Study Site, Sampling Procedure and Sample Size

Two sites were purposively selected from the existing ones (where the initial questionnaire was administered) (Familade *et al*. 2011). The selected sites were Oguro and Papa in Iwo Local Government Area of Osun state. It lies along latitude 7°37´ to 70°40´ N and longitude 4°9´ to 4°13´ E. The altitude is between 233 m and 300 m above the sea level, temperature range is between 18.5 and 30 °C. It is within the derived savanna zone of Nigeria. It is bounded by Lagelu Local Government in the South, Oyo L. G. in the West, Aiyedire L. G. in the East and Ola-Oluwa L.G. in the North. It has an area of 245 km². The population of the area is mostly dominated by Yoruba. The study area is predominantly rural and the people are noted for their involvement in cash and food crop production and processing.

The on-station feed-blocks earlier produced were introduced to farmers and offered to their animals. Subsequently, eleven and nine interested farmers were taught how to make gliricidia/cassava-top feed-block at Oguro and Papa respectively. The on-station feed-block formula was used; however, available measurements commonly used by farmers in the area were employed as standards during the training/demonstration. They were allowed a time lag of 7 month to practice the technology. Thereafter, feed-back questionnaire was administered to the selected farmers to elicit constraints encountered in practice and continuity of use of feed-block for small ruminant production in the area.

2.2.2. Data Collection

Data were obtained through survey involving the administration of structured questionnaire by personal contacts and discussion. The questionnaire was designed to furnish with information on socio-economic background of the respondents such as age, sex, marital status, religion etc. feed-block technology: its practice and constraints. Out of the 20 trainees, 18 were available and the questionnaire was administered to them.

2.2.3. Data Analysis

Data generated from the present study were analysed using descriptive statistics such as frequencies, percentages, means etc.

3. Results and Discussion

3.1. Study 1: On-Station Assessment of Feed-Block for Ruminant Production

3.1.1. Proximate Analysis

Presented in Table 2 is the chemical composition (% on DM) of on-station feed-blocks for small ruminants. CTB was lowest in crude protein, ether extract and ash but highest in crude fibre (Table 2). However, GB/CTB was highest in crude protein and ash but least in crude fibre. Hence, GB/CTB feed-block can be a good supplement to grazing small ruminants in dry season when protein is the most limiting nutrient for ruminant productivity. Also, the ash content could be an indication of high mineral content while the low crude fibre composition is an attribute that improves/enhances feed intake.

The crude protein levels in feed-blocks were high and this may be due to the fact that browses show the potential contribution as protein feed resources for ruminants (Ondiek *et al*. 2010). This range of crude protein seemed adequate for small ruminants since NRC (1981) recommend 11 - 14% crude protein to be modest for ruminant production while Devendra and Mc Leroy (1987) reported that 11% CP is ideal for normal weight gain in sheep and goats. This is an indication that the feed-block so produced can serve as supplement for small ruminant production in dry season when forages are low in quality. On the whole, the high crude protein content of the feed-block makes it suitable as a source of concentrated supplementary nitrogen necessary for microbial protein synthesis in the rumen (Kellaway and Leibholz, 1983).

The crude fibre of feed-blocks in the present study was low. Mecca and Adegbola (1980) reported that the digestible fibre content of shrubs all over Africa has been found to be low compared with grasses. The low level of crude fibre in the present study might give room for increase voluntary intake of low quality diets to meet fibre requirement for rumination and this will lead to better performance of the animals. Preston and Leng (1987) also reported that feed-block is important for animals to increase mucosa cell growth, thereby improving the ability of ruminants to utilize fibrous feeds.

Feed-block	CP	CF	EE	Ash	NFE
GB	17.9^{b}	15.0^{b}	13.0^{a}	12.0^{b}	42.1^{ab}
CTB	15.3^{c}	18.0^{a}	10.0^{b}	12.0^{b}	44.7^{a}
GB/CTB	20.1^{a}	16.2^{b}	12.0^{a}	14.0^{a}	37.7^{c}
SEM	0.48	0.47	0.39	0.47	0.81
P value	0.028	0.030	0.016	0.019	0.020

Table 2: Proximate composition (% on DM) of on-station feed-block for small ruminants
^{abc} *Means within the same column without superscript in common are different* (P<0.05).

Where GB = Gliricidia-based feed-block, CTB = cassava-top based feed-block, GB/CTB = Gliricidia/cassava-top mixture feed-block, CP – Crude protein, CF – Crude fibre, EE – Ether extract, NFE – Nitrogen free extract SEM – Standard error of means

3.1.2. In Vitro Gas Production of On-Station Feed-Block

Presented in Figure 2 is the *in-vitro* gas production of on-station feed-blocks. Gas production is an indication of digestibility (Fievez *et al*. 2005) as well as fermentable carbohydrate level of feed. At the onset of fermentation, gas production was lowest in CTB and highest in GB feed-block. However, at mid fermentation, it was least GB/CTB feed-block and highest in CTB feed-block). While at termination, GB produced the least volume of gas and GB/CTB feed-block exhibited the highest gas volume. It implies that GB/CTB might be highly digestible, increase feed intake, thereby enhance growth rate.

The quantity of gas produced during fermentation reflects the amount of substrate digested and the microbial metabolic pathway (Doane *et al*. 1997). Gas production helps to measure digestion rate of soluble and insoluble fractions of roughages (Menke and Steingass, 1988; Cone *et al*. 1996). Gas volume has also shown a close relationship with feed intake (Blummel and Becker, 1997) and growth rate (Blummel and Ørskov, 1993). The result is consistent with findings of Getachew et al (2004) that gas production rate of roughages including grass or legume differed. It may also be due to the content of fermentable carbohydrate (in binder; starch and forages) and available nitrogen in forages used for the feed-blocks (Aregheore, 2000). Nature and fibre levels, presence of anti nutritional factors had been reported to influence the amount of gas produced during fermentation (Babayemi, 2007). The author further stated that high crude protein in feed/fodder enhanced microbial multiplication in the rumen, which may affect the extent of fermentation. Similar effect was observed in the present study i.e higher crude protein containing feed-blocks produced higher gas volume (GB/CTB feed-block).

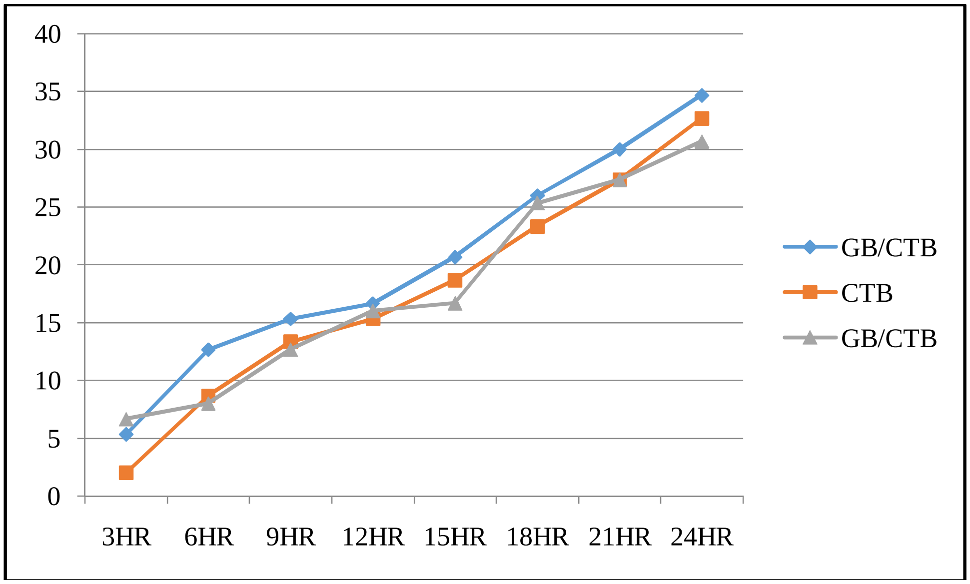

Figure 2: In-vitro gas production of on-station feed-blocks

Note: GB/CTB = Gliricidia/cassava-top mixture feed-block, GB = Gliricidia-based feed-block and CTB = cassava-top based feed-block

3.1.3. Fermentation Parameters of On-Station Feed-Block

Table 3 shows the fermentation parameters of on-station feed-block for small ruminant production. Organic Matter Digestibility (OMD) was the least in CTB and highest in GB/CTB. This is an indication that GB/CTB will be more accessible to microbe than either CTB or GB. Degradability was lowest in GB and highest in GB/CTB. Short chain fatty acid which is an indication of energy made available to the host animal was similar among feed-blocks (P=0.20) and same trend existed for methane production.

Feed-block	OMD	CH_4	Degradability	SCFAs
GB/CTB	50.3[a]	16.7	66.4[a]	0.48
GB	37.4[b]	15.3	53.1[c]	0.43
CTB	37.1[b]	16.0	56.8[b]	0.45
SEM	0.88	1.44	0.82	0.024
P value	<0.001	0.573	<0.001	0.115

Figure 3: Organic matter digestibility, methane gas, degradability and short chain fatty acid of on-station feed-block

[abc] *Means within the same column without superscript in common are different* (P<0.05).

Where GB = Gliricidia-based feed-block, CTB = cassava-top based feed-block, GB/CTB = Gliricidia/cassava-top mixture feed-block, OMD – Organic matter digestibility, SCFAs – Short chain fatty acids, SEM – Standard error of means

The gas production is said to be directly related to its organic matter digestibility. The OMD value is a good measure of the amount of feed which is accessible to the microbes in the rumen (Fievez *et al*. 2005). The observed OMD in the present study were low compared to the work reported by some researchers (Abdulrazak *et al*. 2000). This might be due to the presence of anti- nutritional factors in the forages; condensed tannin which is present in both GB and CTB had been reported to depress rumen carbohydrate degradation (Barry and McNabb, 1999). However, the observed degradability range is higher than the range of 40-50% recommended by Preston (1986) for any feed stuff to be considered as ruminant feed resource. It was observed that the higher the gas production, the higher the methane gas produced by the feed-block. Methane production represents a significant energy loss to ruminants; it also contributes to global warming, which is a worrisome phenomenon in the recent times. In most cases, feedstuffs that showed a high capacity for gas production were also observed to be synonymous for high methane production (Babayemi, 2007).

3.2. Study II: Feed-Back of On-Farm Acceptance of Feed-Block for Small Ruminant Production

3.2.1. Feed-Block Technology as Practiced by Small Ruminant Farmers in Iwo Local Government Area

Shown in Table 4 is feed-block technology as practiced by small ruminant farmers in Iwo Local Government area. Most of the trainees (61.1%) practiced the feed-block technology after its demonstration. This is quite impressive; it might be due to the fact that the respondents had seen dry season feeding of small ruminants as a nagging problem that needed urgent attention. Several factors have been revealed to influence agricultural technologies or innovations adoption, these include, among others, the needs of the farmers, their level of awareness as well as their income level (Roger, 1995).

All the farmers that practiced technology offered feed-block (100%) to their animals and they all reported that their animals (100%) accepted the feed-block. Taiwo *et al*. (2005) also reported a similar trend that feed-blocks were acceptance by sheep and goats in an on-farm study.

The trained small ruminant producers that failed to practice the making of feed-block (38.9%) were asked for the reasons why they did not practice it. Most of the respondents (63.6%) reported to be constrained by time; however, minority (9.1%) attributed non-practice to lack of labour. Majority ascribing constraint to lack of time might be due to the fact that the trainees were mostly females. They were married, having family responsibilities, house chores and various occupations to attend to which could have kept them perpetually busy and unable to attempt making any feed-block. Sourcing for the raw materials for feed-block production may not be a great challenge to the farmers, but time to mix the raw materials together may be a little demanding.

None of the respondents accredited the non-practice of feed-block technology to be due to none availability of raw materials and financial constraints. This could be traced to the fact that materials used for making the feed-blocks were available, affordable and accessible to the farmers in this area. While about 27% of the respondents attributed the non-practice of feed-block technology to small number of animals to be fed.

Questions	Frequency	Percentage
Respondents Who Practiced the Technology		
Yes	11	61.1
No	7	38.9
Did You Offer It to Your Animals?		
Yes	11	100.0
No	0	0
Was It Accepted by the Animals?		
Yes	11	100.0
No	0	0
Why Did You Not Make the Feed-Block?		
Availability of raw materials	0	0
Small number of animals to be fed	3	27.3
Lack of labour	1	9.1
Financial reason	0	0
I don't have time	7	63.6

Table 4: Feed-block technology as practiced by small ruminant farmers in Iwo Local Government Area
Note: Multiple responses are possible

3.2.2. Levels of Constraints to the Continual Practice of Feed-Block Technology by Small Ruminant Farmers in Iwo Local Government Area

Presented in Table 5 is the level of constraints encountered while practicing the feed-block technology by small ruminant farmers in Iwo Local Government Area. The trainees that practiced the technology (11) were asked for the constraints encountered while practicing the technology. Most of the respondents expressed financial constraints (9), lack of labour (9) and small number of animals to be fed as no constraints. Minor constraints were reported to be due to non-availability of raw materials (5), small number of animals to be fed (2), lack of labour (1) and financial constraint (1). However, major constraints were due to lack of time (4) and small number of animals to be fed (1).

Constraints	Not A Constraint	Minor Constraint	Major Constraint
Financial	9	1	0
Lack of labour	9	1	0
Small number of animals to be fed	7	2	1
Availability of raw materials	5	5	0
I don't have time	5	1	4

Table 5: Levels of constraints to the continual practice of feed-block technology by small ruminant farmers in Iwo Local Government Area
Note: Multiple responses are possible

Some of the respondents reported lack of time as major constraint to the practice of feed-block technology. This might be due to the fact that most of the trainees were married females; with lots of family activities giving them little or no time for such extra curriculum activity. Also, many of the respondents indicated financial constraint and non-availability of raw materials as no constraint and minor constraint respectively. This could be traced to the fact that underground work had been done to ascertain feed resources available and affordable in the area that can be harnessed and used for feed-block production. The awareness and rate of adoption of livestock-related technologies in smallholder mixed farming systems worldwide is consistently low, because of the existing research and extension set up and other related constraints (Francis and Sibanda, 2001; Parthasarathy Rao *et al.* 2005). The major reason for this shortcoming is that researchers and development planners do not have proper perspective of the resources, environment, and felt needs of resource poor farmers. In order to solve this problem, approaches that guarantee effective linkages among researchers, extension workers, decision-makers and farmers are needed to produce a better learning environment.

4. Recommendation

A small scale feed-block production unit can be established in the study area.

5. Conclusion

The on-station feed-blocks were adequate in nutrients as supplement for small ruminant production in dry season however; GB/CTB was the best. On-farm feed-block was accepted by small ruminant producers as well as their animals. Most farmers practiced the feed-block technology. However, major constraint to the continual use of feed-block as supplement in the study area was due to inadequate time for production. This is an indication that the feed-block technology was accepted by farmers in the area.

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