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Non-conventional Feed Resources for Sustainable Livestock Farming in Changing Climate Scenario in Arunachal Pradesh

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Introduction

In livestock production system, it is traditional to feed cereals, cakes and meals in the ration. With increase in human population and urbanization the area under fodder or cereal production cannot be increased. There is a huge gap between demand and supply of all kinds of feeds and fodders. Also, rise in global temperature is threatening food and fodder security as a whole. Climate change affects natural resources (such as water sources, land and pastures), biodiversity and livestock health. This has a direct effect on livestock production and livestock systems and as such it is not desirable for the livelihood of the people especially those residing in hilly region. The situation is acute in developing countries where annual feed deficits and increasing animal populations are major problems.

In India, there is already a shortage of 25,159 and 117 million tonnes of concentrates, green forages and crop residues, constituting respectively a shortage of 32,20 and 25 per cent of the requirement (Ravi Kiran *et al.*, 2012). In North eastern region poor quality and shortage of proper livestock feed is a great impediment in enhancing livestock productivity. Only a few numbers of feed mills are in operation in the region, which are unable to produce quality animal feed and meet the demand for feed.

In West Siang district of Arunachal Pradesh livestock husbandry is an integral component of prevailing farming systems. This region accounts 6.9 per cent cattle population, 9.3 per cent mithun, 6.91 per cent goat,

11.6 per cent pigs and 8.4 per cent poultry population of the state. But due to remoteness, inaccessibility and unaffordable cost of concentrate feed, the rural hill farmers of this region has evolved low input production system which mainly dependent on local vegetation's, crop residues. Hence, emphasis need to be given to non-conventional feed resources for filling the gap for need and supply.

Non-conventional feed resources (NCFR) generally refer to all those feeds that have not been traditionally used for feeding livestock and are not commercially used in the production of livestock feeds. As per (FAO, 1985) some of the distinctive features for non - conventional feed are as follows:

- They are the end products of production processes and consumption that have not been used, recycled or salvaged.
- They are mostly of organic origin and can be obtained either in a solid, slurry or liquid form.
- The economic value of these non-conventional feed resources is usually less than the cost of their collection and transformation for use and consequently, they are discharged as wastes.
- Feed crops which generate valuable NCFR are usually excellent sources of fermentable nutrient molecules such as cassava and sweet potato and this is an advantage to livestock especially ruminants due to their ability to utilize inorganic nitrogen and non-protein nitrogenous sources.
- The majority of feeds of crop origin are bulky poor-quality cellulosic roughages with high crude fiber and low nitrogenous content that are suitable for feeding mostly ruminants.
- Some of these feeds contain anti-nutritional components which have deleterious effects on the animals and not enough is known about the nature of the activity of these components and ways of alleviating their effects.
- Non-conventional feed resources have considerable potential as feed materials and some of their value can be increased if there are economically viable technological means for converting them into some useable products.
- Substantial information is required on chemical composition, nutritive value, the presence of anti-nutritional components and value in feeding systems.

Generation of NCFR

Most non-conventional resources are usually regarded as waste. When it is recycled or reprocessed and converted into valuable products for human and livestock they become new feed materials of importance. In addition, they can be used to supplement the existing limited feed resources.

Limitation of NCFR

They are numerous factors may account for the limited use of several crop residues, AIBPs and are listed below :

- Low nutritive value.
- Short period of utilization (seasonal availability).
- High moisture content (e.g. citrus pulp, tomato pulp, olive cake, etc.).
- High cost of handling and transportation from the production site (tomato pulp, olive cake, grape marc, etc.) to the farm.
- Farmers are not aware of the nutritive value of some feed sources and the way for their efficient integration in livestock feeding.
- Competition with alternative users (fuel, compost, etc.).
- Presence of anti-nutritional factors (phenolic compounds mainly tannins, saponins, etc.).
- Dehydration may cause loss of protein value (Maillard reactions).
- Lipid peroxidation (rancidity of high fat products, e.g. olive cake).
- Mould growth (aflatoxins) may cause toxicity.

Some of the commonly available non-conventional feed resources available in the region are as follows

Maize

The leftover of maize consist of (a) the stalk, (b) the husks, skins and trimmings and (c) the cobs. The grain is recovered from the cob by de-husking the ear. The stalk which is usually referred to as stover (Devendra,1985) is obtained during harvesting of maize. This portion along with the husk, skin and trimmings are usually fed to ruminants. The harder portions are used for making silage or compost.

Rice

Rice is one of the major components in the region. The rice when sent for milling large amounts of byproducts like rice straw and rice husks (15-17%), broken rice (4-5%) and rice bran (6-10%) are produced.

Rice straw

It is used for feeding of ruminants (Doyle, Devendra and Pearce 1986). Rice straws contain only 3 to 5 percent crude protein. Animals supplemented with only straw diet will usually not gain any weight and very often will actually lose weight. Hence, enrichment of straw with nitrogen/protein and energy is necessary. For good growth on straw diets, a level of 8 to 10 percent protein is needed for young stock.

Rice husk

As a roughage source only small levels, of about 5% rice husk in the total diets, can be included to give the best results. Support for this finding is found in the results of practical feeding trials of Tillman *et al.*, (1969) who demonstrated that 3% raw husk gave the best dressing percentage in bullocks, and in digestibility studies with steers where a 5% level of husk gave a higher digestible energy value than the 20% level (White, Reynolds and Hembry, 1971).

Rice bran

Rice bran results from the physical abrasion and separation of the hull from rice grain, which is used for human consumption. Rice bran is produced when the hull and fragments of the hull are blended with some of the germ. When rice bran is supplemented at 0.4 percent of body weight, it has approximately the same energy value as corn grain fed at the same level (Foster *et al*, 1993). Fresh rice bran contains sufficient oil which is easily available and palatable source of energy in the pig diets. But with higher addition in diet, the digestibility of energy and protein goes on decreasing with the increasing level of fat and fibre. However, the metabolizability of the energy and protein was better in pigs fed Rice bran in the diet.

Broken rice

It comprises mainly of germs, chipped and broken kernels. Because of its low fibre content and high energy value, its valuable energy gets, especially for substituting other energy feeds in diets for pigs and poultry. Several studies have shown that broken rice can easily substitute maize

without any loss in performance. Broken rice has been used up to levels of 30, 40, and 50%, compared to a maize diet (50% inclusion) in growing pigs and there was no significant between the two groups of experimental animals (Mellish, *et al.*,1973). Khajarern, *et al.*, (1979) in Thailand used 50.7% level inclusion of broken rice in broiler diets and did not observe any loss in the performance of the birds.

Rice brew waste

This is the material that remains after grains have been fermented during the making process. These materials can be fed as dried brewer's grains. Brewers' dried grain (BDG) when produced is sun dried to reduce the moisture content up to a level of 8-10 %. In swine less than 5per cent should be included in the rations as the low energy level, low lysine and tryptophan values may limits its use in pig ration. In poultry ration with enzyme feed supplementation at a certain level should be provided. BDG with Kemzyme-HF @ 0.75 g/kg diet was incorporated in broiler ration at a level of 5 % for economic production (Swain *et al.*, 2005) .In Arunachal, popular form of pig feeding is distillery waste from rice mixed with other feeds, such as rice bran and broken rice mainly for feeding boar for fattening purpose. The following mixing ratio is commonly used in combination with distillery waste i.e. Rice bran (2 kg)+ broken rice (1 kg)+ distillers' residues till gravy (Jini *et al.*, 2009).

Damaged Soybean grain

When properly roasted it can be used with minimum number of feed ingredients for pigs and poultry. It contains around 43-48% proteins. Simple roasting is sufficient to detoxify its anti-nitritional effect. The roasted grains can be fed in poultry ration upto 20 per cent.

Rice bean grain

The protein content varies from 14 to25 per cent, with high amounts of vitamins, calcium and iron. When properly treated, it can be added in the diet up to 30-40% on DM basis without any adverse effect on growth performance.

Ragi

Cost of feed per kg meat production was lowest in chicks fed diet with 50 % maize replaced by ragi. It may be concluded that ragi could replace up to 50 % maize in the diet of laying Gramapriya chicks. Results suggested that unground bajra and ragi could replace maize completely

in the diet of laying hens without affecting the egg production, egg weight, feed efficiency and other quality parameters in addition to production of stronger shell (Swain *et.al*, 2009).

Sugarcane

Sugarcane and sugarcane residues may be considered as an alimentary alternative for feeding ruminants. Cane tops are palatable and cattle can be maintained entirely on cane tops with little supplement of protein either as concentrates mixture or leguminous feeds. Sugarcane leaves have high crude fiber content (40-42% DM) and the leaves are also rich in soluble carbohydrates. They are potential feed resource for ruminant in the dry season (Pate, 1981).The residue after juice extraction from the sugarcane plant referred as bagasse constitutes approximately 15-20% of sugarcane tops with a moisture content of about 50% renders it suitable feed for ruminants especially dairy cows (Randal, *et al.*, 1967).

Banana waste

Banana wastes are by-products of banana harvesting and packing for human consumption. It include small-sized, damaged bananas, banana peels, leaves, young stalks and pseudo stems, which can be fed to livestock. Fresh plantain and banana fruits may be ensiled with molasses, grass, legumes, rice bran etc to feed ruminants. Whole, fresh banana leaves, stalks and pseudo stems are chopped and directly fed to pigs either fresh or sun-dried. Its inclusion in ration depress the utilization of the nitrogen. Hence, it is necessary to provide both energy and nitrogen supplementation during the preparation of ration. Banana foliage and wheat straw (75:25) ensiled with molasses and urea (Baloch *et al.*, 1988) could replace 50 percent of green maize in the rations of lactating cows/ buffaloes without altering milk production. Dried banana pseudostems have been fed to goats and sheep at levels of 20-50% in diets with no adverse effects, but daily weight gains were depressed (Poyyamozhi and Kadirvel, 1986). Banana peels are widely used by small, marginal and landless farmers as complementary feeds for ruminants in the tropics. Their nutritive value is similar to that of cassava or citrus peels. In grass-fed Zebus, the addition of 15-30% banana peels in the diet increased weight gain significantly without causing health problems or affecting palatability (Hernan Botero, Enrique Toro and Rios, 2000). In goats, dry ripe plantain peels can replace up to 100 percent maize without adversely affecting growth performance, and were found to be an economical source of carbohydrates (Aregheore, 1998).

Pineapple wastes

Pineapple by-products consist basically of the residual pulp, peels, stem and leaves. During production of pineapple, rough handling of fruits and exposure to adverse environmental conditions during transportation and storage can cause up to 55% of product waste (Nunes *et al.*,2009).Dried and ensiled pineapple waste can be used as supplemental roughage and could replace 50% roughage in the total mixed ration for dairy cattle (Sruamisri,2007). On feeding twenty four cross bred local goats for 80 days was found that dehydrated pineapple by-products would increase the digestibility with increase in weight of the animals (Costa *et al.*, 2007).

Citrus waste

The residue left after extraction of the juice is called citrus pulp (50-70 percent of the fruit by weight). It contains 60-65 percent peel, 30-35 percent internal tissues and up to 10 percent seeds (Crawshaw, 2004). Dried citrus pulp can replace 20 percent concentrate in dairy cattle (Assis *et al.*, 2004) and up to 30 per cent in lactating ewes (Fegeros *et al.*, 1995) without adversely affecting DM intake, rumen metabolites, digestibility, milk yield or milk protein and fat contents. Citrus pulp silage can be included at 5-10 percent in the diet of growing and finishing pigs. Weight gain and feed intake tend to increase improved carcass quality by increasing meat content and carcass length, and reducing back fat (Cerisuelo *et al.*, 2010). In poultry with limits up to 5-10 percent did not affect feed intake, egg production and egg weight in laying hens (Yang and Chung, 1985).

Tapioca

It can be used for feeding of pigs, cattle goat and poultry. The roots are suitable for feeding of young animals and fattening pigs. Properly dried whole tuberous roots can replace maize in non-ruminant rations if the HCN does not exceed 100 ppm. Tapioca root meal can complete substitute for maize in diets for dairy cows producing approximately 12 kg of milk per day. Cassava could totally replace oats in the concentrate feed of cattle (Mathur *et al.*, 1969). Maize can be substituted by cassava root meal upto 15 % in broiler rations (Kinabo, 1977). In crossbred pigs, Das *et al.* (2012) reported that, tapioca root meal can be included up to a level of 50 percent in the diet of pigs in Nagaland.

Taro

Taro leaves has great potential as animal feed in particular for pigs. But due to their oxalate content the leaves should be soaked, washed or

cooked and dried or ensiled before feeding them to livestock. An trial of inclusion of boiled taro cocoyam in the diets of weaned pigs carried out by Agwunobi *et al.* (2002) revealed that there was no significant difference in feed intake, weight gain and feed efficiency upto 50% replacement of maize. Chittavong Malavanh *et al.* (2007) who successfully fed ensiled taro leaves to pigs during reproduction and lactation. *Colocasia esculenta* meal effectively replace 25% maize in the diets of broiler finishers for raw sundried and 50% for boiled sundried (Mohammed *et al.*, 2009).

Sweet Potato

Sweet potato is cut into slices or mixed with vines and household waste. Sweet potato is an ideal livestock feed, as the roots can provide a source of energy and the leaves can provide protein .Study carried out in Nigeria recommended 27 and 30 % levels of sweet potato in the starter and finisher diets (Agwunobi, 1999). Boiled sweet potato tubers could be fed to the level of 40% of total dry matter intake to the weaned piglet for better growth rate and nutrient utilization whereas up to 60% of total dry matter intake to grower pig along with good quality protein supplement for better growth performance. The sweet potato vines can serve as a nutritive and palatable feed for cattle. The unmarketable and poorly developed tubers can also be utilized in animal feed.

Browse Foliage

The Arunachal Pradesh is one of the biodiversity 'hot spot' in the world. The forests in mid-hills are very rich in flora and fauna diversity. The locally available fodder trees, shrubs and herbs have high potential values as sources of feed for domestic livestock and wildlife. These can be successfully incorporated into production system to provide additional feed resources for use in mixed diets of livestock. Numerous tree and shrub species have been investigated.

Gmelina arborea: This is a deciduous tree of medium size grows up to 40 meters in height and has diameter of 60-100cm (Jenson, 1995). It is fast growing tree, specimens shows about 4 rings per inch of radius. The leaves are simple and are more or less heart shaped and are usually 10-25cm long and 5-18cm in width. *Gmelina arborea* is commonly found in forests of mid-hills of Arunachal Pradesh. *Gmelina* is found in subtropical and tropical climates except in very hot and temperate climate. It is grown up to 1000 m altitude. It can only tolerate drought for short period. It is moderately frost hardy. Severe frost may kill the shoots, but they recover and sprout again from the base. The tree grows well in climates with mean annual temperatures of 21-28°C (Jenson, 1995) and grows best in

deep well drained base rich soils with a pH between 5.0 and 8.0. *Gmelina* is suitable to grow as a shade tree. It can easily be planted along boundaries of the field crops. *Gmelina* can be grown among agricultural crops. In this system of cropping, *Gmelina* is benefited due to watering and manuring done to agricultural crops. Rotations of 5-8 years reported to be commonly followed. The recent studies by Amata and Lebari (2011) on the nutrient profile of the fresh leaves reveal appreciable levels of crude protein (14% DM), crude fiber (6.7% DM), ash content (1.3% DM) and ether extract (12.7% DM). Metabolizable energy sources for livestock values were found to be appreciable (1368 Kcal Kg^{-1}) an indication of its suitability as an energy sources for livestock diets. The study revealed appreciable levels of essential amino acids and this indicates that the leaves could be a good source of protein. The recent studies by Amata and Iwelu (2012) show the potentials of the fresh fruit pulps of *Gmelina arborea* as non-conventional feeding material.

Moringa oleifera: Fugile (2001) has described *Moringa* as a miracle tree and has been shown to have numerous uses, amongst which are the coagulant properties of the seeds. Studies by Foidi *et al.* (2001) have shown that it can be used as a protein meal in livestock diet as it contains approximately 60% crude protein. These studies have also shown that the leaves of the plant are edible and highly nutritious and provide approximately 25% crude protein. Total digestibility of these leaves is high. The leaves are free of anti-nutritive factors such as tannins, phenols and saponins. These studies have also revealed that the iron content of the leaves is up to 582 mg/kg DM, The β-carotene is up to 400mg/kg and vitamin C content is as high as 9.2 g/kg.

Trema orientalis: It is an evergreen shrub or tree up to 18 m in height. A short basally swollen bole, heavy branching and rounded to spreading crown. It has an extensive root system that enables it to survive long periods of drought. Leaves simple, alternate, stipulate, along drooping branches, to 14 cm long, papery, rough to the touch and dull above, short grey hairs below, the edge finely toothed all round, blade unequal sided. *T. orientalis* is found in the lowland humid tropics. The studies on the nutrient profile of the leaves by Heli *et al.* (2008) show that it contains DM (38.30%), CP (10.60%), EE (1.39%), CF (25.6%), NFE (56.20%) and TA (6.2%) revealing its potential as non-conventional feed source.

Terminalia catappa: The tree grows to 35 m (115 ft) tall, with an upright, symmetrical crown and horizontal branches. *Terminalia catappa* has corky, light fruit that are dispersed by water. The seed within the fruit is edible when fully ripe, taste almost like almond. This tree belongs to the family Combretaceae. Some of its common names include tropical almond, Indian

almond, Jangli badam, Java almond. It has nutty fruits that taste like commercially grown almonds. The leaves contain several flavonoides (Such as kaempferol or quercetin), several tannins (Such as punicalin, punicalagin ortercatin), saponines and phytosterols. Due to this chemical richness, the leaves (and the bark) are used in different medicines for various purposes. *Terminalia catappa* requires bright sunlight, moist and well drained soil. It is salt and draught tolerant and can be planted in frost free areas. The studies on the nutrient profile of the leaves by Amata and Lebari (2010) and that of the seeds by Amata and Nwagu (2012) reveal the potentials of this plant as a non-conventional feed source for livestock feeding in the state.

Bauhinia purpurea: It is a small to medium-sized deciduous fast-growing shrub or tree with a round, symmetrical, moderate dense crown to 10 m tall, young branches becoming glabrous or nearly so (glabrescent). It belongs to the family Leguminosae. Leaves are simple, alternate, base rounded to shallow-cordate, up to 12 cm x 12 cm, deeply 2-lobed at apex up to 1/3-1/2, ca. 7-12 cm long, and equally wide, margin entire and the surfaces smooth and glabrous. It occurs at lower elevations especially frequent along the valleys in its native habitat. It demands plenty of light and requires good drainage. Severe frost kills the leaves of seedlings and saplings, but they recover during summer. The species is frost-hardy but least drought-hardy compared to other species of Bauhinia. The studies on the nutrient profile of the leaves by Heli *et al.* (2008) indicate that it contains DM (40.4%), CP (14.9%), EE (4.20%), CF (17.4%), NFE (58.3%) and TA (5.2%).

Ficus hirta: It is an evergreen shrub or a small tree with a much-branched crown; it can grow up to 10 metres tall. The plant is sometimes harvested from the wild for local use as a food and medicine. It is found in forests and forest margins at low elevations. In secondary jungle, waysides, waste-places, and by the edge of the forest, from the lowland ascending to 2,000 metres. The studies on the nutrient profile of the leaves by Heli *et al.* (2008) found that it contains DM (29.7%), CP (19.9%), EE (2.3%), CF (29.8%), NFE (40.20%) and TA (7.8%) revealing its potential as non-conventional feed source.

Bamboo: Bamboo is a member of the grass family 'Poaceae'. Two important characters which make majority of bamboo distinct from other grasses are: (i) Woody perennial habit and (ii) peculiar flowering and seeding behavior. It is a fast growing, wide spread, renewable, versatile, low-or-no cost, environment enhancing resource with potential to improve livelihood security in the years to come, in both rural and urban areas. Arunachal Pradesh occupies an important position among the bamboo bearing states of India. Bamboo forms a major constituent of

the forest vegetation of Arunachal Pradesh. Tropical, subtropical and temperate species are found well distributed in the State. In Arunachal Pradesh, which has about 46 bamboo species, the bamboo flora is seen up to an elevation of 2000 m or even more. The studies on the nutrient profile of the leaves of various bamboo species by Singh K.A. (1999) found that the CP content in the bamboo leaves of various plant species varied from 9 to 19 percent and the CF content varied in the range of 18 to 34 percent. The leaves are also found rich in mineral content. This makes the bamboo as a potential non-conventional feed resource for sustainable livestock farming.

Conclusion

In Arunachal Pradesh, a distinctive gap exists between the requirements and supplies of nutrients for livestock. It is desirable that adequate feed resources should be built up as one of the mitigation strategy in response to changing climate scenario. The state has considerable amounts of crop residues such as straws and plantation wastes. In addition, majority of the geographical area of the state is under forest vegetation. However, the lack of knowledge about nutritional values and difficulty in handling and using for extended periods may account for their limited use. Therefore, it is essential to increase feeds by improving the nutritive value of crop residues, encouraging agro and social forestry and utilizing other non-conventional feed resources in various permutation and combinations. Crop residues, plantation wastes and browse foliage are increasingly becoming important as feeds in the near future as human and livestock populations are expanding. Special attention should be given to efficient integration of multipurpose fodder shrubs and trees as fodder bank in feeding calendars of livestock under harsh climates. The active involvement of farmers could provide a platform for discussion of the suitability of the different technologies discussed in this paper, thereby enabling scientists to develop, modify or refine their technologies as per the needs of the farming community in changing climate scenario.

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