Potential of Winged Bean as Feed for Sustainable Livestock and Poultry Farming in North Eastern Region of India

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The Northeast (NE) India is the eastern most region of India, comprising of Seven sister states (Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Tripura) and the Himalayan state, Sikkim. Physiographically the region is categorized into the Eastern Himalayas, Northeast hills (Patkai-Naga hills and Lushai hills) and the Brahmaputra and the Barak valley plains. The region

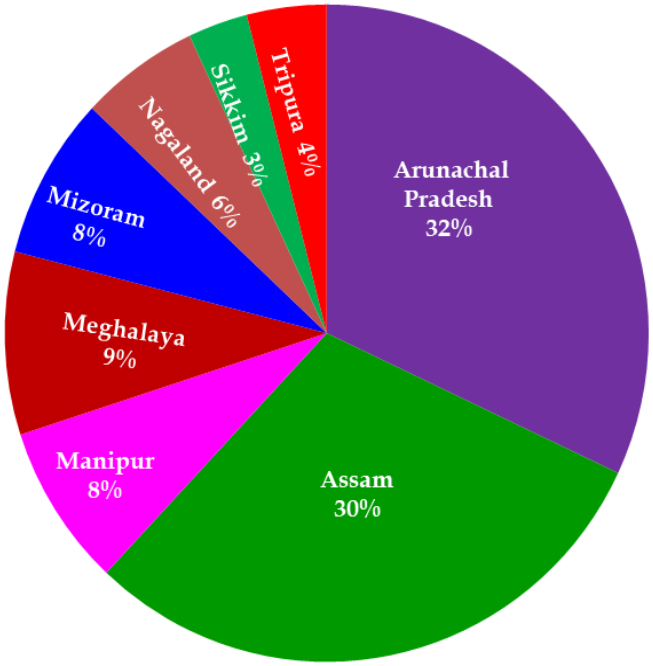

Fig. 1 Geographic area of North Eastern states (%)

lies within the latitude of 21°50′ to 29°34′ N and longitude 85°34′ to 97°50′ E with a geographical area of 2,62,179 km². It constitutes about 8% of India's size and its population is approximately 3.1% of the total Indian population (Census, 2011). About 90% of its entire border area is shared with China (southern Tibet) in north, Myanmar in the east, Bangladesh in the southwest and Bhutan to the northwest. The region has a predominantly humid sub-tropical climate with hot, humid summer, intense monsoon and mild to cold winter. The temperature of the region varies from 15°C to 36°C in summer and zero to 26°C in winter season. The region is endowed with all types of climatic conditions ranging from tropical to alpine and it receives rainfall ranging from 150-250 cm. However, most of the crops grown as a rainfed crop and irrigated area contributes < 20% of the net cultivated area. The southwest monsoon is responsible for bringing 90% of the annual rainfall to the region. April to late October are the months where most of the rainfall in Northeast India occurs with June and July being the rainiest months (https://en.wikipedia.org/wiki/Northeast-India). The region is also considered as a 'biodiversity hotspot' because of its high endemism in higher plants, vertebrates and avian diversity.

There is a decrease in livestock population in 2019 registering a decline of 10.19% in the total number of animals of various species in NER as compared to 2012 while in all India; a positive growth of 4.64 % is recorded during the same period (Table 2). On the other hand, there is an increase in poultry population in 2019 registering a positive growth of 62.57 % in the total number of birds of various species as compared to 2012, which is five times more than the national growth rate during the same period.

Demand-supply of milk, meat and eggs by 2030

The projection study on production and requirement of milk, meat and eggs in NER has been carried out to estimate the demand-supply gap of livestock products by 2030 (Table 3). The growth of livestock rate is based on the Livestock Census 2012 and 2019 (BAHS, 2019). Requirement of milk, meat and eggs is estimated by multiplying the recommended amount of per capita consumption with the population of 2018 and the projected population of 2030 in NER. The population of the region is estimated to be 57415800 by 2030 from 49758267 during 2018. The demand for livestock products is estimated to feed the growing population by 2030. The data shows that the demand is more than supply in all the three animal proteins by 2030. The projected milk, meat and egg production reveals that the region would have a deficit of 696.68 thousand MT, 259.44 thousand MT and

85200.90 lakh numbers by 2030 from 1033.71, 299.33 and 78207.94, respectively during 2018. However, the deficit percentage of milk, meat and eggs would be reduced from 41.54%, 54.94% and 87.31% during 2018 to 24.26%, 41.26% and 82.44% respectively by 2030 with the present livestock and poultry production system in the region. Therefore, to make this region self-sufficient in milk, meat and eggs a comprehensive approach should be under taken to accelerate the production and productivity of livestock and poultry birds in NER.

Agriculture is the major source of employment and livelihood for around 70% of the population in this region (Feroze *et al*., 2010). Animal husbandry is an important subsector of agriculture and it plays an important role in Indian economy. It is a major source of income for the landless and marginal farmers which directly influence their socio-economic status. They not only contribute to their income but also their best insurance against any natural calamity. The people of this region are confined to their traditional food habits with meat as an integral part and the meat consumption pattern and expenditure in this region are 2-3 folds higher when compared to the National level (Mahajan *et al*., 2015; Kadirvel *et al*., 2018). But the gap between the demand and supply of meat in the North East region is very high which may be due to traditional farming with indigenous breeds having low production potential. However, one important factor that affects the production and quality of the meat is feed. The high cost and, sometimes, the lack of availability of commercial protein supplements is one of the main limitations to efficient animal production by small holders. According to Longe (2006) and Bamgbose *et al.* (2011), the high cost of conventional feedstuffs has brought about the need to have alternative feedstuffs that can replace the expensive ones in order to reduce the cost of livestock production. Moreover, locally grown forages and grain legumes offer ecological benefits such as nitrogen fixation, soil improvement, and erosion control which contribute to improve cropping efficiency. Non-conventional feedstuffs offer the best alternatives in our environment for reducing feed cost and therefore a reduction in the cost of meat and animal products (Dafwang *et al*., 2001). The search for alternative sources of protein from legume crops in lieu of expensive ones has been advocated (Adebowale and Lawal, 2004; Ibe and Makinde, 2014).

Potential of winged bean as feed for livestock and poultry

Winged bean (*Psophocarpus tetragonolobus*) is an underutilized potential crop belonging to the family Fabaceae. Winged bean is popularly known as "One Species Supermarket" for its nutrient-dense green pods, immature seeds, tubers, leaves and mature seeds. It is known by many names such as Manila bean, Goa bean, princess pea, four-angled bean, asparagus pea, and Bepuithlanei or Bepuipawr in Mizo. It is believed to have originated from South-eastern Asia or Papua New Guinea (Bassal *et al*., 2020). It thrives well in the hot and humid climates and is distributed widely in the Southern and North-eastern regions of India. Winged bean is nutrient-rich, and all parts of the plant are edible. Leaves can be eaten like spinach, flowers can be used in salads, tubers can be eaten raw or cooked, seeds can be used in similar ways as the soybean (Khan, 1982). It is grown in pits and needs organic manure and fertilizers like other beans. To trail the branches it needs a Bower or trellis. It grows vigorously and flowering starts within three months. A robust, climbing herbaceous perennial plant, it can attain 5 metres in height. The flowers are of different colour; it may be blue, white or purple. Flowers have a sweet taste because of the nectar they contain. The pods are four sided with characteristic wings, and vary in length from 6- 36 cm (upto 50 cm) containing 5-20 seeds in each pod (Sahoo et al. 2002). The globular shaped shining seeds may be white, yellow, brown, black or mottled and vary in weight from 0.06-0.5g each. All parts of the plant, i.e., seeds, flowers, leaves, pods and tuber-like-roots are edible. The young tender pods can be stewed, boiled, fried, roasted or made into milk. The seeds contain 40% proteins and the roots contain about 20% proteins, which are supposed to be 10 times more than in potatoes or yams. Winged beans are also rich in carbohydrates and vitamin A (300 to 900 IU). Its tender leaves make good sauce and curry.

According to Ningombam *et al.* (2012), winged bean is a lesser known nutritious leguminous plant grown luxuriantly in Manipur. Highest crude fat (1.7%) was present in mature seed and crude protein (50.7%) was present in fully mature seed. The maximum amounts of total sugar (488.90 mg g-1), non-reducing sugar (415.95 mg g-1) and starch (420.60 mg g-1) were recorded in tuber. The plant was also found to have significant quantity of minerals. As regard to the mineral content, mature pod case showed the maximum amount of K (8.9 mg/g), Ca (8.06 mg/g) and Mg (5.72 mg/g). The tuberlike-roots are eaten after boiling or frying. The plant is a good fodder for cattle (Rai *et al*., 2005).

In Mizoram, winged bean is grown sporadically in jhum lands as the sole crop and mixed farming. It is generally consumed as a raw vegetable, soup, curry, chutney, and salad. This crop is abundant in natural antioxidants (Maimako *et al*., 2022), polyphenols and flavonoids (Kim *et al*., 2003; Bassal *et al*., 2020). The seeds have shown promising blood-pressure owering properties (Chay *et al*., 2018) and tuberous roots are highly protein-rich (Kortt and Caldwell, 1984) and hence can be used as a substitute for protein supplements (Soni *et al*., 2022). Additionally, substantial nodulation plays an important role for increasing soil fertility (Lepcha *et al*., 2017). Few reports are available on use of winged bean as feed for livestock and poultry. Nurpaidah *et al.* (2021) observed that there was effect of protease in diets containing winged bean seeds (*Psophocarpus tetragonolobus*) on performance of broiler chickens. The additive protease interaction with concentrations of 2.5% and 5% and level of winged bean seeds on the diet had a significant effect on the feed conversion ratio value ($P<0.05$). De Lumen *et al.* (1982) also studied the effects of replacing soybean meal with different varieties of winged bean meal on broiler performance. Similarly, Suntara *et al.* (2023) reported that the effects of the replacement of cassava chips with winged bean (*Psophocarpus tetragonolobus*) tubers (WBTs) on gas production parameters, in vitro degradability, and ruminal fermentation in ruminant diets. WBTs can be used effectively when combined with grass (Ruzi and Napier). The implementation of winged bean tubers as a novel alternative feed may effectively replace cassava chips without affecting rumen function. Thus, it can be concluded that as winged bean has excellent nutritional content and can flourish luxuriantly even in unfavorable climatic conditions, it can be used as an alternative feed for sustainable livestock and poultry farming in North Eastern region of India.

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Table 1: Livestock and poultry population of India vs North East

State	Cattle	Buffalo	Pig	Goat	Poultry
Arunachal Pradesh	3,39,221	6,379	2,71,463	1,59,740	1599575
Assam	1,090,239	4,21,715	2,099,000	4,315,173	46712341
Manipur	2,24,472	36,230	2,35,255	38,697	5897637
Meghalaya	9,03,570	15,714	7,06,364	3,97,503	5379532
Mizoram	45,701	2,109	2,92,465	14,820	2047810
Nagaland	78,296	15,654	4,04,695	31,602	2838944
Sikkim	14,8010	1,144	27,320	90,506	580864
Tripura	7,39,031	7,131	2,06,035	3,60,204	4168246
NER Total	13,387,540	5,06,076	4,242,597	5,408,245	69224949
All India	**1,93,462,871**	**1,09,851,678**	**9,055,488**	**1,48,884,786**	**851809931**

Source: 20th Livestock Census, 2019

Table 2: Change in livestock and poultry population (2012 – 2019)

	Livestock Population (in thousands)			Poultry Population (in thousands)		
	2012	**2019**	**% Change**	**2012**	**2019**	**% Change**
NER	27106.53	24343.18	-10.19	42580.47	69224.95	62.57
All India	512057.30	535828.88	4.64	729209.32	851809.93	16.81

Source: 20th Livestock Census, 2019

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