



Farm animal genetic resources in agro ecosystem of north east India

G KADIRVEL¹, L ANANDAKUMAR SINGH², MOKIDUR RAHMAN³ and N MANORANJAN SINGH⁴

ICAR Research Complex for NEH Region, Umiam, Meghalaya 793 103 India

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ABSTRACT

North Eastern Region of India is the homeland of diverse animal genetic resources and representing a unique agro-ecosystem with integrated subsistence low input tribal production system where farm animals play an important role in improving the socio-economic status and livelihood of the people. The total livestock and poultry population of this region is about 70.13 million (6.85% of India) of which 92.76% is indigenous population. Among the 183 registered breeds of livestock and poultry in India, this region has 19 registered breeds which include two cattle, one buffalo, two goat, two sheep, four pig, two horse and ponies, one yak, four chicken and one duck breed. Besides many uncharacterized farm animal breeds/populations are reared by tribal farmers in the region, which are described as their local names. The review, enumerates the farm animal genetic resources of this region and their current status, descriptions, unique features, utility and their economic valuation and cultural importance as well as future conservation strategies. Precise and reliable estimation and evaluation of different economic and climate resilient traits of indigenous farm animal germplasm and their economic valuation, genetic characterization, documentation and registration is highly warranted. It has also suggested and proposed a model for the implementation of strict policy from central and state agencies to facilitate *in situ* conservation with active community participation and *ex situ* conservation through application of modern biotechnological tool, which is warranted to maintain the diversity of farm animals in north east region of India.

Key words: Animal genetic resources, North-east, Unique traits, Utility

The North-Eastern region of India is one of the major biodiversity hotspots in the world. This region is not only contributing plant diversity but also represent a huge diversity in animal genetic resources. The unique domestic species like yak, mithun and wild species like one-horn rhino and pygmy hog are the heart throb of this region and well known globally. This region of India lies between 21.5° N to 29.5° N latitude and 85.5° E to 97.5° E longitude and comprise Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura. It occupies about 8% of total land area and 4% of total population of the country (Census 2011). This region has a unique agro-ecosystem such as high annual rainfall (2500–3000 mm), subtropical to alpine climate, undulated and hilly terrain with the altitude ranges from 1,000 to 3,000 m above the mean sea level. About 65.59% of the geographical area is covered by forest (India State of Forest Report 2015) which is mostly under private or community ownership. This unique geographical location leads to diversity in animal genetic resources and its production system. By and large, this region practices integrated subsistence low input tribal production system where livestock and poultry play a

complementary and vital role in improving the socio-economic status and livelihood of the people.

The total livestock and poultry population of this region is about 70.13 million, which includes 13.29 million cattle, 0.58 million buffalo, 0.57 million sheep, 7.85 million goat, 3.95 million pig, 23,000 horse and pony, 1,000 mule, 2,000 donkey, 18,000 yak, 0.30 million mithun and 43.53 million poultry (Table 1). Among them, 92.76% is indigenous population and remaining is crossbred population (Table 2). Although there are 183 registered breeds of livestock and poultry in India, this region has only 19 registered breeds which include two cattle, one buffalo, two goat, two sheep, four pig, two horse and ponies, one yak, four chicken and one duck breeds. However, many uncharacterized farm animal breeds/populations are reared by tribal farmers in the region, which are described as indigenous local. The diversity of domesticated livestock and poultry breeds developed due to years of evolution within a specific niche as a result of adaptation and selection. These indigenous animal genetics resources are playing vital role in food and livelihood security of the people and maintaining genetic diversity in the ecosystem. These indigenous animals are able to survive and reproduce in adverse agro climatic condition even in low or/ and zero input production system. The objective of this review is to enumerate the farm animal genetic resources of region and their descriptions, unique

Present address: ¹Principal Scientist (velvet.2007@rediffmail.com), ^{2,3,4}Senior Research Fellow (ds30056@gmail.com, ahmedsuman690@gmail.com, manovet6@gmail.com), Division of Animal Production.

Table 1. State wise livestock and poultry population in NE region of India (in thousands)

State	Cattle	Buffalo	Sheep	Goat	Pig	Horse and ponies	Mule	Donkey	Yak	Mithun	Total livestock	Total poultry
Arunachal Pradesh	464	6	14	306	356	4	0	0	14	249	1413	2244
Assam	10308	435	518	6169	1636	14	0	1	0	0	19081	27216
Manipur	264	66	11	65	277	1	0		0	10	694	2500
Meghalaya	896	22	20	473	543	2	0	1	0	0	1957	3400
Nagaland	235	33	4	99	504	0	1	0	0	35	911	2178
Mizoram	35	5	1	22	245	1	0	0	0	3	312	1271
Sikkim	140	1	3	113	30	1	0	0	4	0	292	452
Tripura	949	11	3	611	363	0	0	0	0	0	1937	4273
Total	13291	579	574	7858	3954	23	1	2	18	297	26597	43534

Source: 19th Livestock Census (2012).

Table 2. Share of major indigenous livestock and poultry population in NE region in India

Species	National level			NE region		
	Total (million)	Indigenous (million)	% of share	Total (million)	Indigenous (million)	% of share
Cattle	190.90	151.17	79.19	13.29	12.39	93.24
Sheep	65.06	61.28	94.19	0.57	0.55	96.82
Pig	10.29	7.83	76.14	3.95	2.15	54.43
Poultry	511.71	217.49	42.51	43.53	41.17	94.58
Buffalo	—	108.70	100	—	0.57	100
Goat	—	135.17	100	—	7.85	100
Horse and pony	—	0.62	100	—	0.023	100
Total (including yak, mithun, donkey)	1023.37	683.18	66.76	70.13	65.05	92.76

Source: 19th Livestock Census (2012).

features, utility and importance which will be an important aspect for conservation and breeding strategies in this region of India.

Cattle genetic resources

The total cattle population of NE region is about 13.29 million out of which 93.34% is indigenous. However, most of the animals are of non-descript type except in Assam and Sikkim where the two indigenous registered cattle breed Lakhimi and Siri are found. Among the eight states of NE region, Assam possesses 77.36% of the total cattle population followed by Tripura (7.14%) and Meghalaya (6.74%). Mizoram is found to have the lowest cattle population with only 35,000 heads (Livestock Census 2012). The trend in the cattle population dynamics from 2007 to 2012 is generally towards negative growth excepting Assam, Meghalaya and Sikkim where the total cattle population increased by 2.66%, 1.01% and 3.70% respectively.

Siri cattle: It is a medium size zebu cattle of NE region distributed in Sikkim, and district Darjeeling of West Bengal. It is said to be the native of Bhutan where it is called as Nublang. The population drastically declined from 79,000 to 13,948 during 2003–2012 and came under the threatened category. Siri is the largest cattle breed as compared to other cattle breeds of NE region of India.

Typical cervico-thoracic type of hump and long hairs are the characteristics of this breed. This animal has excellent draught ability in hilly terrain because of their strong legs and feet. The daily milk yield of Siri cattle ranged from 2.0 to 6.5 kg with a fat content of 2.8 to 5.5% (Tantia *et al.* 1996).

Lakhimi cattle: It is a small size zebu cattle breed distributed in entire Assam. The total population of Lakhimi cattle is about 79 lakh. Relatively short legs and small bowel shaped udder are the characteristics of this breeds. The average milk production per lactation is about 270–375 kg (NBAGR 2017). Bullocks are excellent draught animals and are used in agricultural operation. Besides these two registered breeds, each state of NE region has its own local cattle known by their local name like Manipuri cattle, Arunachali cattle, Mizo cattle etc. However, their descriptions and specific features are not well documented.

Buffalo genetic resources

The NE region of India is the land of swamp buffalo and has important evolutionary divergent from wild to swamp and swamp to riverine buffalo (Mishra *et al.* 2009). This region has 0.58 million buffalo population of which Assam possess 75.12% (0.43 million) followed by Manipur with 11.40% (0.066 million) (Livestock Census 2012). There is

a decreasing trend in the buffalo population of NE region from 2007–2012 except Manipur where marginal increase (1.06%) in the buffalo population. Among the 15 registered buffalo breeds of India, NE region has only one registered breed i.e. Luit (Swamp). However, three different varieties of swamp buffalo are found in this region i.e. Assamese buffalo, Sikkimese buffalo and Manipuri buffalo.

Luit (Swamp) buffalo: It is a medium size black coloured buffalo and is mostly found in upper Brahmaputra valley of Assam and some parts of Mizoram, Manipur and Nagaland bordering Assam. Compact and strong built up body with light white stocking up to knees in both fore and hind legs are the characteristics of this breed. The average lactation milk yields of Luit buffalo ranges from 385 to 505 kg. Bullock having excellent draught ability for carting and ploughing especially in muddy field for paddy cultivation (NBAGR 2018).

Assamese buffaloes: It is a medium size buffalo having primarily black body coat colour found in upper, lower and central Brahmaputra river valley region in Assam. The buffaloes are reared in traditional nomadic system of management under zero input conditions, locally termed as *khuti* system. They are mainly reared for sale of young male calves which are primarily used for carting and agricultural operations. Milk of Assamese buffaloes is popularly known as *Khuti* milk. The average milk yield ranges from 0.5 to 6 liter/day (Mishra *et al.* 2008).

Manipuri buffaloes: It is distributed in the hilly as well as valley/plain regions of different parts of Manipur. Based on the habitat and distribution, Manipuri buffaloes are of two types, viz. hill type locally termed as Ching-eroi and valley type locally named as Tamgi-eroi. The population of Manipuri buffaloes is estimated around 0.066 million. It is genetically found to be pure domesticated swamp type based on their karyotypic profile (Mishra *et al.* 2009). Typical white markings on either side of muzzle and lower jaw are the characteristics of Manipuri buffalo. They are mainly used for meat purpose as well as different agricultural operations and carting (Mishra *et al.* 2009).

Sikkimese buffaloes: These buffaloes are the natives of the Sikkim state. These are small size and black or grey colour buffalo, and are mostly found in different districts of Sikkim. These buffaloes are well suited in hilly terrain for carrying heavy load because of their short strong legs and compact hardy body. The milk yield of this buffalo is very poor (Pathak and Singh 2001).

Pig genetic resources

The NE region is contributing major share in pig genetic resources of India, as contributes 38.38% of country's pig population (Livestock Census 2012). The total pig population of this region is about 3.95 million of which Assam possesses 41.37% followed by Meghalaya (13.73%), Nagaland (12.74%) and Tripura (9.18%). Sikkim have the lowest pig population with only 30,000 heads (Livestock Census 2012). Among the 8 registered pig breeds of India, 4 breeds belong to NE region namely Niang Megha,

TenyiVo, Doom and Zovawk (NBAGR 2017). Besides these one important indigenous pig known as Mali pig is very popular in this region.

Niang Megha: It is also known as khasi local pigs mostly distributed in Garo, Khasi and Jaintia hills of Meghalaya. The estimated population of Niang Megha pig is about 4.3 lakh. They are well known for nesting behaviour before farrowing and strong mothering ability. Body coat of this pig is covered with long and coarse bristles, which protect them from cold weather. Pigs attain sexual maturity at an early age. The average age at sexual maturity and age at first farrowing is about 197 and 326 days respectively (Zaman *et al.* 2014).

TenyiVo: It is a small size black colour pig mostly found in Chakesang, Mao, Tuensang and Angami district of Nagaland. The name TenyiVo literally translates into the "Pig from Angami". This breed in Sema tribe is called Suho and amongst the Lotha tribe it is known as Votho. The estimated population of TenyiVo pig 60–70 thousand only. Early sexual maturity and good mothering ability are the characteristics of this breed. The average at first estrous and age at first farrowing are 182 and 298 days respectively (Chusi *et al.* 2016).

Doom: It is a medium size black colour pig mostly distributed in lower parts of Brahmaputra valley of Assam. The estimated population of Doom pig is about 3,000 only. They are comparatively larger than other local pig breeds of this region. They migrate in groups in scavenging system with a flock range of 90 to 150 (Banik *et al.* 2016). Pointed snout and thick line of coarse bristle on the crest region are unique body conformations of Doom pigs. The average age at first estrus and age at first farrowing are 202 and 340 days respectively (Banik *et al.* 2016).

Zovawk: It is a black colour pig with white spot on forehead and white patches on belly, and is mostly distributed in different parts of Mizoram. The estimated population of zovawk pig is about 39,000. Concave top line and long bristles on midline are characteristics of Zovawk pig. The average age at first fertile service and age at first farrowing are 323 and 437 days respectively (Kalita *et al.* 2018).

Mali pig: Mali is a black colour indigenous pig breed, widely distributed in different parts of Tripura. Short legs and drooping rumps are the characteristics of this breed. These pigs are well known for their early sexual maturity. The average age at puberty and age at first farrowing are 127 and 281 days respectively (Dandapat *et al.* 2010).

Goat genetic resources

The NE region has 0.79 million goat population of which Assam contributes 78.50% followed by Tripura (7.78%), Meghalaya (6.01%) and Arunachal Pradesh (3.89%). Mizoram has the lowest goat population with only 22,000 heads (Livestock Census 2012). The goat population in this region showed 32.13% growth from 2007–2012. Among 34 registered breeds of the country, this region has only two registered goat breeds known as Sumi-Ne and Assam hill goat.

Sumi-Ne: It is a medium size goat also known as Nagaland long hair goat and is found in different parts of Nagaland. They are mostly reared in traditional open range system with almost zero inputs by the Sumi tribes of Nagaland. The estimated population of Sumi Ne goat is 4,500. They are mainly reared for silky fibre production. Long silky fibres obtained from these goats are used by local people for making traditional items for socio-cultural significance (NBAGR 2017).

Assam hill goat: It is a small size breed of goat, and is mostly found in the hilly terrain of North Cachar, Karbi-Anglong districts of Assam and also in the adjoining hilly tract of Meghalaya. They are well known for their good quality meat, higher rate of prolificacy and adaptability in low input poor management condition. Twinning is very common in Assam hill goat (Zeshmarani *et al.* 2007). The average age at first heat and age at first kidding were 266 and 439 days respectively (Kadirvel *et al.* 2013).

Sheep genetic resources

The total sheep population in NE region is about 0.57 million of which Assam accounts for 90.40% followed by Meghalaya (3.49%) and Arunachal Pradesh (2.44%). Mizoram has the lowest sheep population (only 1,000 heads) (Livestock Census 2012). The trend of sheep population in this region showed 39.02% growth from 2007–2012. The states of Assam and Manipur witnessed increase in sheep population while the other states showed static to declining trend (Livestock Census 2012). Among 43 registered breeds of the country, this region has only two registered sheep breeds named as Banpala sheep and Tibetan sheep.

Banpala sheep: It is a medium size sheep with compact body covered with coarse wool, and are found in different parts of Sikkim and in neighboring Western Bhutan and Eastern Nepal. The breed derived its name as it is mostly reared inside the forest ('ban' means forest and 'pala' reared). This sheep is reared mostly by the traditional shepherd tribe called as Gurung. It is a typical dual purpose breed reared for both coarse wool and meat production. Banpala sheep produces 1 kg of coarse wool per year which is obtained in two shearing (Bhutia *et al.* 2006).

Tibetan sheep: It is a medium sized sheep mostly distributed in Northern Sikkim and Kameng district of Arunachal Pradesh. Tibetan sheep is famous for production of excellent lustrous carpet quality wool. The fleece of this sheep is relatively fine and dense on belly and leg region. Animals are shorn twice a year with average greasy fleece weight per clip ranging from 400 to 900 g (Kumar *et al.* 2017).

Equine genetic resources

North East region of India is bestowed with diverse indigenous animal genetic resources including that of equines. However, in the last decade, the equine population showed declining trend in the region. The equine population in this region is 23,000 (Livestock Census 2012). Although there is limited horse population, this region has two

important registered breed, viz. Manipuri pony and Bhutia horse.

Manipuri pony: Locally named as Meitei Sagol is found mainly in Manipur and different parts of Assam. They are descendants from Asian wild horse. Manipuri ponies are intelligent, extremely tough with tremendous endurance and reared in semi wild system. It has 11–13 hands wither height with a good shoulder, short back and well developed quarters (Gupta *et al.* 2012). Manipuri pony are extensively used for polo game throughout the world. They are also utilized for transportation, hunting and racing.

Bhutia: It is a small size mountain horse also known as "Bhotia pony or Bhote-Ghoda mostly found in Sikkim and Arunachal Pradesh. Short neck, large head with pronounced jaw and very strong short legs are the characteristics of this breed (Gupta *et al.* 2012). Bhutia pony are well known due to their terrifying habit while moving they always keep to extreme edge of a mountain path to avoid the bumping against the cliff wall on the inner side as they used to carry luggage on either side of their body.

Poultry genetic resources

NE region of India is famous for different groups of chicken and duck breeds reared by farmers under traditional systems of management. The total poultry population in this region is around 43.53 million. With the exception of Manipur, Mizoram and Tripura, the trend of poultry population in this region showed positive growth from 1997 to 2012 (Livestock Census 2012). Among 19 registered chicken breeds of India, NE region has 4 registered chicken breeds, viz. Chittagong, Daothigir, Miri and Kaunayen. This region has the only registered duck breed of India namely Pati duck (NBAGR 2017). Besides these, a local duck breed known as Nageswari duck is very popular in this region.

Miri fowl: These breeds of chicken are mostly found in Dhemaji, North Lakhimpur, Sibsagar, Dibrugarh and Majuli district of Assam. The name of the bird itself is derived after tribal people name called Miri or Missing tribe since the birds are reared by them. They are reared mostly for meat as well as eggs. The dressing percentage ranges from 65–74%. The average egg produced per year is around 60 to 70 (Vijh *et al.* 2005).

Daothigir: It is a chicken breed mostly distributed in Kokrajhar, Bongaigaon, Barpeta, Dhubri and Nalbari districts of Assam. The name of the breed is derived from the name of a plant in this region called Thigir (*Dillenia indica*). The colour of the flower is similar to the plumage colour of these birds. The shape of these flowers also resembles the comb of these birds. In Bodo language Dao means bird and hence these birds are known as Daothigir. It is a dual purpose breed for both egg and meat production. Annual egg production is about 60–70 (SAPPLPP 2013).

Kaunayen chicken: It is an indigenous chicken breed locally known as Kaunayen/Kwakman/Koman mostly. It is found in valley of Manipur. The word Kaunayen is a combination of two Manipuri words namely 'Kauna' means kick/fighting and yen means hen/ poultry. Elongated body

with long neck and long legs are the characteristics of this breed. Kaunayen birds are mainly used in commercial purpose for cock fighting because of their martial qualities (Vij *et al.* 2016).

Chittagong fowl: These birds are locally known as Malay, and are mostly distributed in Meghalaya and Tripura bordering Bangladesh. They are comparatively larger than other breeds of chicken in this region. The average body weights of cock and hen are 3.5–4.5 and 3–4 kg respectively (Yadav *et al.* 2017). They possess the characteristic features of a good game bird. Chittagong fowl are reared for both meat and egg production, and has cultural and economic significance.

Pati/Desi duck: Pati breed of duck is distributed in different parts Assam which constitute about 85.6% of the total duck population in Assam (Islam *et al.* 2002). Pati ducks are mainly reared under natural conditions and they lay about 60 to 70 eggs annually. They are more resistant to disease and better acclimated to the local environmental conditions (Islam *et al.* 2002).

Nageswari duck: These birds are locally named as Nagiare mainly distributed in the Barak valley of Assam bordering Meghalaya, Tripura, Mizoram and the neighboring country Bangladesh. They are reared under scavenging or free-range system with a flock size ranging from 5 to 200 (Zaman *et al.* 2005). Adult ducks forage in the rice fields all through the day and are confined during night time in a house made of the bamboo (called Ugartol). The average annual egg production is about 140 to 150 (Islam *et al.* 2002).

Other livestock genetic resources

Mithun: It is a unique bovine mostly found in high altitudes varying from 300 to 3000 m above mean sea level in the sub-tropical rain forests of NE region of India. They are primarily of meat type bovine having long and massive body. The average body weight ranges from 400 to 500 kg (Gupta *et al.* 1999). Mithuns are associated with social and cultural significance of the people of this region. The total population of mithun in NE region is about 0.29 million of which Arunachal Pradesh has the highest number of mithun (0.25 million) followed by Nagaland (0.03 million). Apart from these two states, Manipur and Mizoram has about 10,000 and 3,000 mithun population respectively (Livestock Census 2012). The mithun population in this region showed an increasing trend with an increase of 12.5% from 2007–2012. Two distinct types of mithuns, viz. Nagami mithun and Arunachali mithun have been described by Verma (1996) based on their distinct habitat and geographical distribution in NE region of India.

Yak: It is a multipurpose domesticated bovine found in high altitude ranges from 3000–6000 m above the mean sea level and well adapted to the cold weather. They can even survive without food for several days and without any appreciable adverse effect on their health (Arora *et al.* 1998). Yak has a relatively heavy head with wide convex forehead and long, narrow and slightly dished face (Nivsarkar *et al.*

1998). Yaks has two types of hair coats, an outer coarse hairy coat and an under coat of fine woolly fibre. They are termed as horse tailed buffaloes because of their peculiar horse-like tail with long hair. In NE region, yaks are found in the cold humid mountains of Sikkim and Arunachal Pradesh. The population of yak in this region is about 18,000 which decreased by 5.56% from 2007–2012 (Livestock Census 2012). Two distinct types of yak, viz. Arunachali yak and Sikkimese yak have been described by Pal *et al.* (1994) based on their geographical distribution in NE region of India.

Utility of indigenous animals of NE region of India

In contrast to other parts of the country, livestock play an integral part of social, cultural and economic livelihood as well as source of nutritional security of the people of this region. These animals served multiple purposes of the owner and make an important component of farming system of NE region of India. The indigenous animals are extensively used as draught power for different agricultural operation and act as transportation vehicle in undulated hilly areas of this region. The manure of indigenous animals is of great demand as source of bio-fertilizer for organic production because this region is the emerging organic hub of the country (Rahman *et al.* 2009). Many of the indigenous animals in NE region have played an important role in specific culture and religion for a particular community. For example yak and mithun are essential for social and cultural identity of tribal people in this region. Ownership of mithun indicates the prosperity and social status of an individual in many tribes of Arunachal Pradesh (Gambo 2015). The Adi tribe of Arunachal Pradesh believes that sacrificing mithun during marriage ceremony will bring glory and blessings to newly engaged couple (Nimasow *et al.* 2015). Mithun is also sacrificed at the time of death of a person to appease the God for the peace of his/her soul (Nimasow *et al.* 2015). Exchange of live mithuns is the most common bride price among most of the tribes of Arunachal Pradesh and Nagaland in India (Verma 1996). Almost all the body parts of a yak are associated with cultural and religious significance of Monpa tribe. The skull of yak is used for writing of mantras and kept at prominent places like Buddhist Temple-Gonpa, and houses as a symbol of strength and safety (Norbu and Riba 2015). When a Tibetan girl marries a young herder, yak is always given as dowry along with the bride (Wu Ning 2003). Meat and blood of yak are important due to their medicinal values (Meyer 1976). Manipuri ponies are famous for polo game in this region. Buffalo bull fighting (MohJuj) is a prestigious game during 'Bihu' festival of Assamese community. Various food items such as Chilu (yak fat stored in empty stomach of sheep used as edible oil) and Surpi (product of yak milk) in Sikkim; Satchu (smoke dried meat of yak) in Arunachal Pradesh and Sikkim; Dohjem (pork meat item) and Tungrymbai (pork with fermented soybean and paste of sesame seeds cooked together with chopped ginger) in Meghalaya; pork pickle in Nagaland and Bongsha Rep

(smoked beef) in Mizoram are traditional foods of this region and popular throughout the world (Kadirvel *et al.* 2018, Hazorika 2013). Curd prepared from local buffalo milk and duck meat are special food items during Bihu in Assam. In poultry, Kuanayen breed of chicken of Manipur is used extensively for cock fighting, a very popular and valuable game of this region (Vij *et al.* 2015). Traditional cultural instrument such as Pepa made from buffalo horn, Dhol from skin of animals and trophy of different local animal implies the need and importance of farm animal genetic resources in NE region of India.

The indigenous animals of this region possess some unique and climate resilient traits that distinguish them from the animals of other parts of the country. The local pigs possess long coarse bristle on their body coat to protect them from cold weather. The bristle from pigs are utilized for preparation of different type of brush, viz. painting brush, carpet cleaning brush, grooming brush for pet animals etc. (Mohan *et al.* 2014). The local pig attains sexual maturity at early age which increases the life time productivity and is also well adapted in low input hilly ecosystem (Kumaresan *et al.* 2007). The indigenous animals of this region has relatively short and strong legs which help them to carry heavy load in hilly undulated areas. The milk of Assamese buffaloes commonly famous as Khuti milk, is having great market demand due to its high fat percentage and often preferred for preparation of curd and ghee which fetches high prices (Alam *et al.* 2017). Twinning and triplet kidding in Assam hill goat (Zeshmarani *et al.* 2007), adaptability of Doom pig in group migratory scavenging system (Banik *et al.* 2016) and specific milk composition of yak and mithun are the pride of NE region of India.

Economic valuation of indigenous animals of North East India

At present the economic valuation of a particular breed or an animal is based on the production and reproduction and/or economic traits. But the real economic valuations of indigenous farm animals of this region are ignored. To judge the actual economic value, the utility and contribution of indigenous animal in every aspect should be considered in economic valuation. Therefore, consideration of economic valuation including life time productivity, social and cultural valuation, ecosystem maintenance, sustainability and productivity in low input production system, market value of indigenous animal product, climate resilient traits and valuation of animal waste in organic production of indigenous farm animals of NE region is utmost important. There are various methods of environmental economic valuation of indigenous animals already available in literature. These methods are broadly classified into three types (Drucker *et al.* 2001), viz. determining the actual economic importance of the breed/population, appropriate cost of conservation programme and priority setting in breeding programme. Implementation of this method for economic valuation of the indigenous farm animal genetic resources of this region is a pre-requisite

and useful component to protect the farm animal biodiversity of NE region of India.

Conservation of indigenous animals of North East India

The indigenous farm animals are the result of long evolutionary processes. However, their population size is declining because of genetic dilution due to crossbreeding and are facing degeneration. Some of the indigenous breeds or populations like Bonpala sheep, Manipuri pony, Doom pig and all the indigenous poultry breeds of this region are under risk of extinction. So conservation program for protection of the indigenous animals are urgently needed in this region of India.

Existing conservation policy: The government of India as well as all the state governments of North-Eastern state have implemented many schemes and policies for conservation of indigenous animals; e.g. National Programme for Bovine Breeding (NPBB) was initiated in 2014 to conserve, develop and proliferate selected indigenous bovine breeds of high socio-economic importance. The Assam Livestock Development Agency (ALDA) is a state implementing agency of NPBB launch programme for local Swamp buffalo improvement and conservation with the establishment of a nucleus farm at Barhampur (Assam). Similarly, National Livestock Mission was launched in 2014–15 for piggery development in the North Eastern region of India. The government of India sanctioned a project in 2011 for conservation of Banapala sheep. Accordingly, a nucleus farm was established in west for propagation of this threatened germplasm. The government of Manipur implemented conservation policy for Manipuri Pony in 2016. This policy includes development of a breeding tract for Manipuri pony and complete ban on crossbreeding of Manipuri ponies till the population stabilized with the participation of local community. This policy also facilitates cryo-preservation of semen of good pedigree stallions for *ex situ* conservation. In poultry, Rural Backyard Poultry Development (RBPDP) Programme was launched in NE states in 1999–2000 for conservation of local indigenous birds by increasing hatching, brooding facilities and strengthening the poultry farms. However, the conservation scheme or policies implemented for only a few indigenous breeds/populations of this region. So it is very much essential to establish suitable breeding policy and conservation strategies for each indigenous animal breed/population to protect the indigenous animal biodiversity of North Eastern region of India.

Proposed conservation strategies: The conservation of indigenous farm animals should be done by two methods, viz. *in situ* conservation and *ex situ* conservation. For *in situ* conservation each state department of NE region should work in collaboration with central agencies for identification, documentation and registration of each indigenous breed available in this region. The proposed strategy of conservation of indigenous animals of NE region of India is given in Fig 1. The state department should

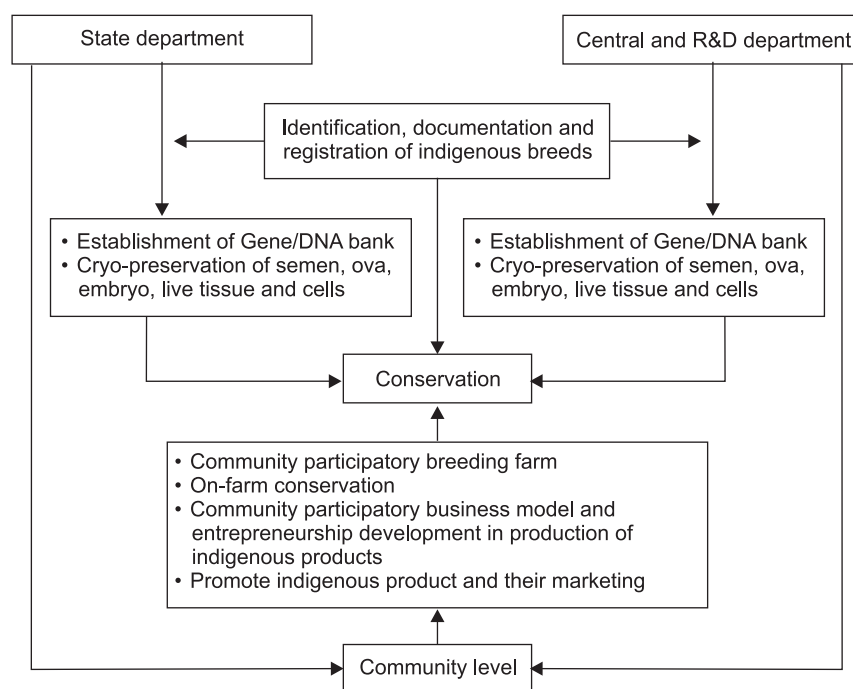


Fig.1. Strategies for conservation of Indigenous animal.

establish organized/nucleus breeding farm for each indigenous breed/population at different places within their breeding habitat. Community participation plays a key role in *in situ* conservation of indigenous animals of this region because majority of the land of this region is community based and most of the indigenous breeds are associated with some particular community. The state and central agencies should facilitate community-based conservation with sustainable and valuable use of indigenous animal in this region. This could be done by creating awareness and capacity building of the local community of this region through technical and institutional support mechanism. The farmer/community of this region should be provided incentives to enhance their attention and interest in rearing of indigenous animals. Establishment of community breeding farm and supply of pure germplasm at village level for propagation of indigenous animals, development of community participatory business model to promote indigenous animal products and entrepreneurship development through training on value addition in indigenous animal products, their packaging, labelling, branding and marketing will be prerequisite for community based conservation in this region. This community participation will provide long term benefit for conservation of indigenous animals of NE region of India.

For *ex situ* conservation, the R&D institute of this region in collaboration with state and central agencies should establish organized animal research stations for each indigenous animal breed at different locations for scientific study. *In vitro* conservation of genetic material such as cryopreservation of semen, oocytes, embryo, stem cell, live tissue, cells etc. for each indigenous breed of this region and their periodic evaluation is warranted. The R&D

institute of this region such as Assam Agricultural University, Central Agricultural University-Manipur, ICAR-RC for NEH region should create gene/DNA bank for indigenous livestock and poultry breed of this region for future purpose. The R&D institutes should also conduct extensive research through application of modern biotechnology to regenerate the endangered breed of this region.

Conclusion

The farm animal genetic resources of this region possess few unique features that are important due to their socio-cultural significance the local people that distinguishes them from the farm animals in others parts of the country. However, introduction of exotic germplasm and unrestricted crossbreeding become a threat for the many indigenous animal resulting decline of their population. Therefore, precise estimation and evaluation of important economic and climate resilient traits of indigenous germplasm and their genetic characterization, documentation and registration are necessary. Implementation of strict policy from central and state agency and institutional support mechanism to promote community participation in *in situ* conservation and application of modern biotechnological tool in *ex situ* conservation are urgent indication for conservation of indigenous livestock and poultry in the north-east region of India.

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