REFEREED ARTICLE

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Domestic livestock in Nepal: production systems, genetic resources, research and the way forward

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ABSTRACT

This paper describes the major characteristics of Nepali small farm production systems with particular reference to livestock and their feed supply. The current and potential contributions of the livestock sector to human welfare, to household income, to food security and to overall biodiversity are also assessed. Nepal's animal genetic resources are extremely diverse (at least 17 species) and have multiple functions. They are yet to be fully characterized but the received wisdom that they are unproductive and of inferior genetic merit is not founded on comparative research or on the several production objectives (including adaptability to the local environment) for which animals are kept. Research in the past has been along classic lines, carried out on station and not always related to the real problems of small farmers. Future research areas should be identified in collaboration with farmers and the extension services, should be mainly applied and adaptive in nature and should be carried out in collaboration with farmers on their farms (On Farm Technology Testing) as well as on research stations.

KEYWORDS: domestic animal biodiversity; smallholder production; food security; research; livestock production objectives

1. Introduction

On a global scale Nepal is a geographically and economically insignificant landlocked country compressed from the north by China and from the west, south and east by India. In its small area, however, it rises from a few metres above sea level on the Indo-Gangetic Plain to the soaring heights of the Himalayas that culminate in the earth's highest point at the peak of Mount Everest over a horizontal distance of less than 200 km. Within its territory of 147,181 KM^2, the nation's projected 2015 population of 28.0 million people (CBS, 2016) live in several physiographic regions and many agro-ecological zones. The Human Development Index (HDI) is very low at 0.428 (UNDP, 2010), putting Nepal 138th in a league table of about 180 nations. Per person nominal Gross Domestic Product (GDP) is US$ 785 (CBS, 2016). Growth in overall GDP was 4.9% during the period of the Eighth Development Plan (1992/1993-1996/1997), 3.6% during the Ninth Plan 1998/1999-2000/2001), 3.4% during the Tenth Plan (2001/2002-2006/2007) and 4.5 per during the Three Year Interim Plan (2007/2008-2009/2010). Over these periods agricultural sector growth rates were lower than the overall at 3.0% (Eighth Plan), 3.3% (Ninth Plan), 2.7% (Tenth Plan) and 3.2% (Interim Plan). Projected rates of increase were not achieved for various reasons but especially due to political instability overshadowing economic issues from the mid-1990s, uneasy labour relations and weak infrastructure (NPC, 2011).

Agriculture employs 67% of the 11.2 million over 15 years old of 'currently employed people': 56% of males and 77% of females work in the sector (CBS, 2009). Livestock and their products contribute greatly to the empowerment of women and other marginalized groups (Bajracharya, 1994; Gurung *et al.*, 2005; Parajuli, 2008). More than 35% of national GDP was derived from agriculture in 2011 – down from almost 48% in 1991, reflecting the growing importance of the service sector and especially tourism (NPC, 2011). Livestock production contributes 31% of agricultural added value and more than 16% to total GDP (CBS, 2014), not accounting for the value of draught power and manure. Animals and their products provide about 20% of household cash income. Livestock support to total household welfare is greater than this simple number indicates due to the value of home consumption. In the mid-1990s the proportion of livestock to total agricultural output was expected to increase from about 30% to 45% over the 25 years to 2020 (NPC, 1995) and the cereal deficit was expected to continue to worsen (Thapa and Rosegrant, 1995). The increase in livestock contribution was to be driven by annual growth rates of 2.9% to 6.1% during the Plan period but the targeted growth was not achieved (Pradhanang *et al.*, 2015).

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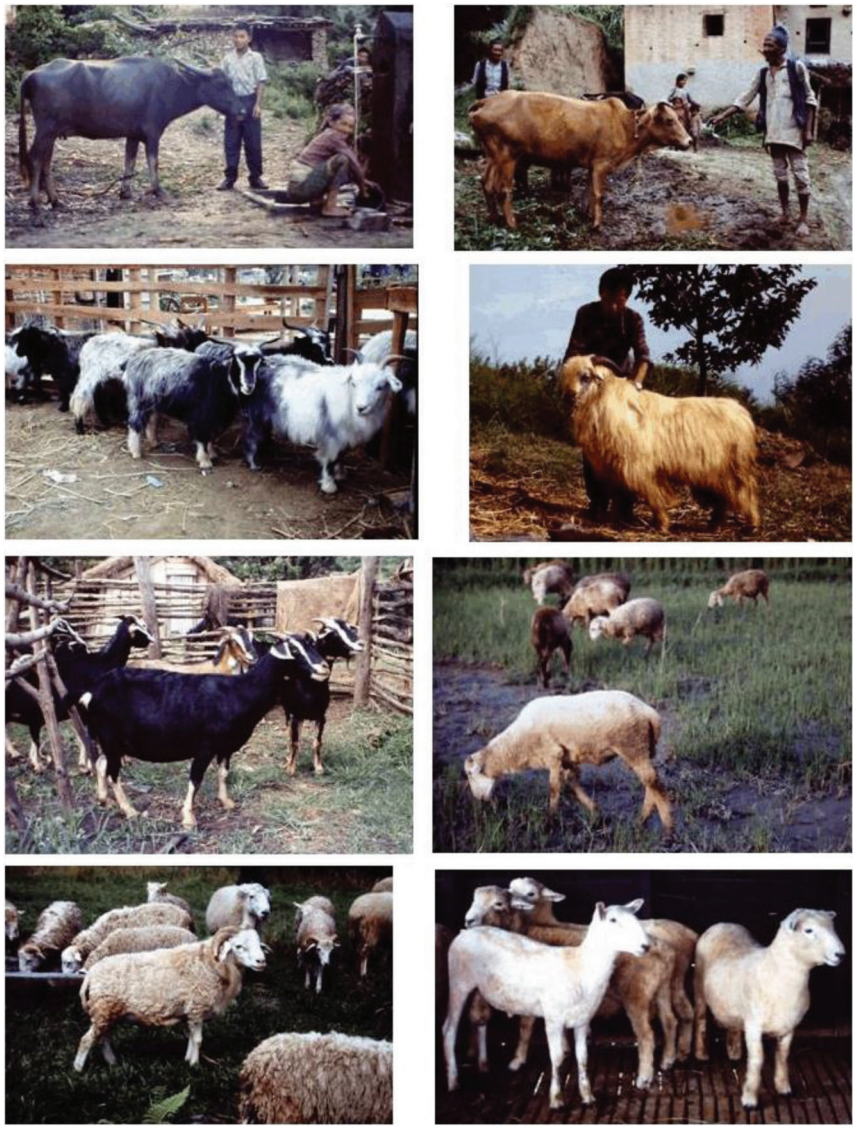

Figure 1: Domestic animal diversity in Nepal – 1 (from left to right, top to bottom) (a) Buffalo heifer at Baramche (1750 m) with its young friend, (b) Nepalese Hill zebu cattle at Rabiopi in Kavre District, Central Region, (c) Tibetan Dwarf goats for sale at the Dashain festival in Kathmandu, (d) Sinhal male goat at the Bandipur Goat Farm of the Nepal Agriculture Research Council, (e) Khare goats selected for colour type at the Bandipur Goat Farm, (f) Lampuchre sheep grazing a rice stubble in the Terai, (g) Kagi sheep at the Lampatan Production Farm, Pokhara, western Nepal, (h) Romney Marsh and Leicester rams from New Zealand on a Government stock farm at Pokhara

Domestic animals in Nepal contribute greatly to the country's already plenteous biodiversity (See Figure 1 and Figure 2).

Livestock include cattle (7.2 million head in 2012/2013), buffalo (5.2 million), goat (9.8 million), sheep (809,000), poultry (48.0 million fowl, 376,000 ducks, 1.5 million pigeons and 52,100 'other' birds), yak and yak-cattle crosses (48,865)[2], pig (1.2 million), equines (23,340) and meat and fibre rabbits (24,240) (MOAD 2013; CBS, 2014). Milk from buffalo (1.2 million tonnes) and cows (492,400 tonnes) is the major livestock product. About 26% of all buffalo and 14% of cattle are lactating at a given time. Buffalo, cattle and yak milk is also converted to cheese, ghee, butter and other products. Buffalo (175,130 tonnes) produce most meat, followed by goat (55,580 tonnes), domestic fowl (42,800 tonnes), pig (18,700 tonnes), sheep (2,720 tonnes) and duck (217 tonnes) (MOAD, 2013): it is illegal to slaughter cattle but some clandestine killing takes place. Some 87.4 million hen eggs and 13.0 million duck eggs were produced in 2012/2013 as well as 588 tonnes of wool (MOAD, 2013). Despite the importance of livestock and the food they provide, consumption per person of the major comestibles is lower than basic needs. Milk availability from domestic resources in 2013 was estimated to be 72.1 litres per person with meat availability being 11.8 kg (NPC, 2013).

Draught is often neglected in assessing livestock's contribution to welfare and the national economy (Abington, 1992). More than 75% of crop land is ploughed by oxen or buffalo. In 1984 it was estimated that livestock produced 1.37 million kilowatts of energy, valued at Nepali Rupees 1300 million (US$ 65 million at that time) (Oli, 1985). The value of power used in other agricultural operations, particularly threshing, and in transport (even goats are used as pack animals in the Hills) should be added to this amount. Further added value derives from livestock manure which, until recently, has been together

[2] In Nepal 'yak' usually refers, in addition to the species, to male animals, 'nak' being used for the female: Yak-cattle crosses are usually referred to as 'chauri' but there are many other names for various levels of hybridization.

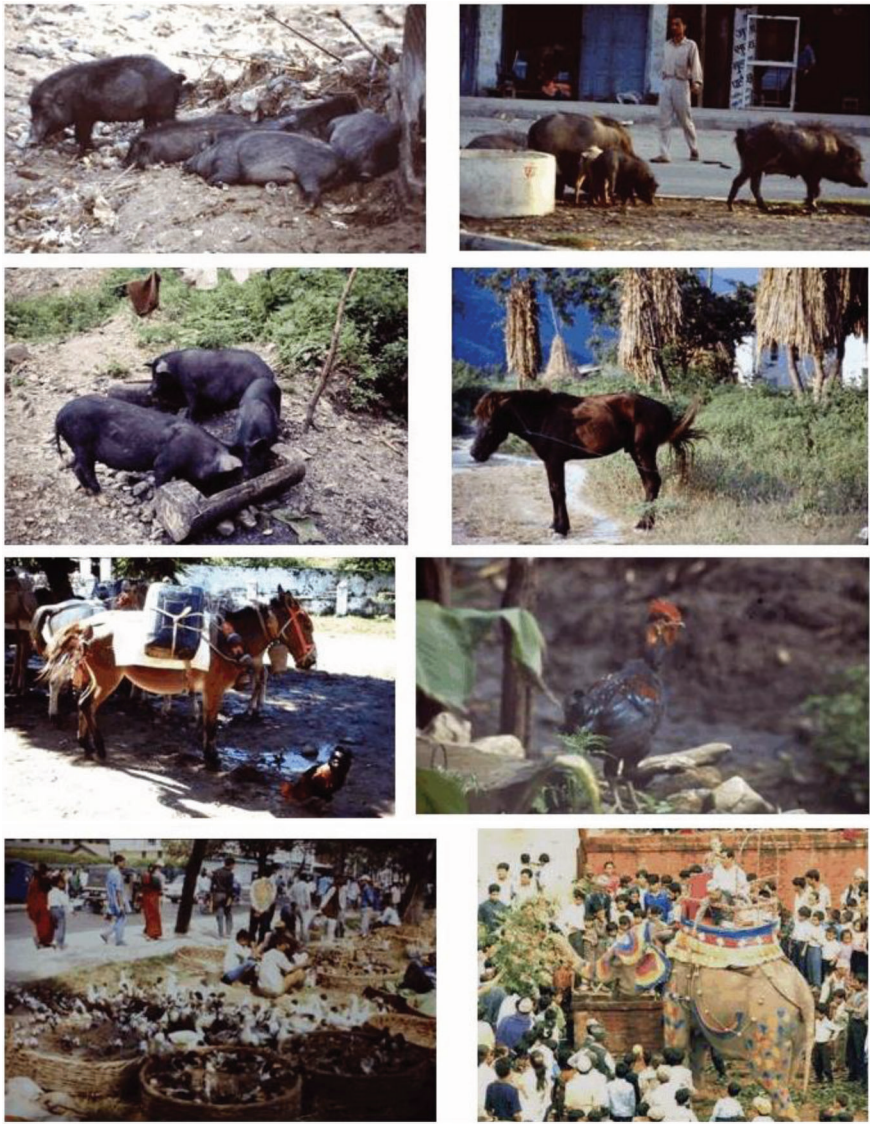

Figure 2: Domestic animal diversity in Nepal – 2 (from left to right, top to bottom) (a) Chwanche pigs resting in shade on a river bank, (b) Hurra pigs scavenging in a Terai town in eastern Nepal, (c) Pakhribas pigs on a smallholder farm, (d) A Terai pony in use by the Nepalese police in Ramechhap district – note stored crop residues in trees, (e) Mules loaded with diesel fuel and grain in Damao, western Nepal, (f) Naked neck Sakini chicken in western Nepal, (g) Mixed species of domestic poultry on sale in a main thoroughfare in Kathmandu at the October Dashain festival, (h) Elephant being prepared for a ceremonial occasion in Bhaktapur

with some composted crop and household residues the sole source of the essential nutrients required for crop production (Takeshima *et al.*, 2016). At the beginning of the 21st century it was estimated that cattle and buffalo produced 33 million tonnes of manure every year which, if all collected would have been valued at USD 58.75 million.

In addition to its use in ameliorating soil fertility and structure dung is used as a fuel by 9.8% of all Nepali households (Joshi, 2002, cited in Rushton, 2009). ''The application of farmyard manure is the traditional and dominant method used by farmers to maintain fertility'' (Ransom *et al.* 2001. p.274). Application of farmyard manure in five time series of on-farm topsoil monitoring over periods of one to three years increased organic matter from 3.3% to almost 3.8%; total nitrogen levels were significantly improved and the enhanced soil organic matter status was reported to improve structure, workability and moisture characteristics (Bishwarkama *et al.* 2014). In the Terai heavy applications of farmyard manure helped to maintain soil fertility and residual levels were sufficient to supply plant nutrients in legume rotated systems (Ojha *et al.*, 2014).[3]

This paper describes the major characteristics of Nepali small farm production systems with reference to indigenous livestock and the research undertaken in the country.

2. Production Systems

Nepal has a great diversity of agroecosystems in relation to its absolute physical area. Altitude, precipitation, temperature, humidity, soil, slope and aspect combine to provide a microcosm of the earth's vegetation types and farming systems. Small farms dominate the sector (Table 1), 22.0% being less than 0.2 ha in area and 31% between

[3] The Terai is a lowland plain that lies across the whole of southern Nepal bordering India at an altitude of between 67 and 300 m: in its natural state it is characterised by tall grasslands, scrub savannah, sal forests and clay rich swamps but in the Nepal of today it is densely cultivated.

Table 1: Number, area and fragmentation of holdings by total area of holding in Nepal

Holding size (ha)	Holdings				Average number of parcels
	Number	%	Total area (ha)	%	
<0.1	355,549	9.56	20,076.5	0.80	1.5
0.1-<0.2	461,957	12.43	68,161.8	2.70	2.1
0.2-<0.5	1,169,503	31.47	396,720.9	15.73	2.9
0.5-<1.0	984,022	26.48	695,060.1	27.55	3.7
1.0-<.2.0	548,974	14.78	749,810.0	29.73	4.5
2.0-<3.0	129,364	3.48	308,568.5	12.23	5.2
3.0-<4.0	39,507	1.06	134,353.1	5.33	5.6
4.0-<5.0	14,881	0.40	65,364.7	2.59	6.0
5.0-<10.0	10,744	0.29	69,177.1	2.74	6.1
⩾10.0	1,054	0.03	15,227.2	0.60	6.8
Total	3,716,555		2,522,519.9		3.2

Source: adapted from CBS, 2013

Table 2: Livestock density (head/km^2) on cultivated land in Nepal

Physiographic unit	Total Livestock Units (million)[1]	Species					
		Cattle	Buffalo	Goat	Sheep	Pig	Poultry
Mountains	2.18	318	120	321	153	30	483
Hills	7.44	217	119	208	27	21	431
Terai	4.05	171	71	107	10	12	192
Nepal	13.67	206	98	174	30	18	333

[1] Livestock Units (equivalent to 250 kg live weight) are preferred here to overall numbers as they allow weighting of all species to a common denominator.
Source: DFAMS, 1990

0.2 and 0.5 ha so that more than half of all farms are less than 0.5 ha (CBS, 2013). The 115,538 landless holdings represent just over 3% of all holdings.[4] In spite of much notional encouragement by Government for commercialization, production is largely for subsistence due to low product prices with no competition among traders and difficulties of access to markets walking up and down the steep hills for distances of up to 20 km (Ransom *et al.*, 2001).

Some 68% of the country's 3.7 million agricultural holdings keep an average of 2.82 cattle, 49% keep an average of 1.90 buffalo, 70% have 4.67 goats, 3% own 6.32 sheep and 0.2% own 7.84 yak and yak-cattle crosses. Of non-ruminant livestock, 13% of households own an average of 1.84 pigs, 0.3% own 1.84 horses, 0.04% own 4.35 donkeys and/or mules and 0.2% own 3.88 rabbits. Domestic fowl are owned by 54% of households with an average flock size of 14.52 birds: indigenous fowl are owned by 52% of households each with 8.60 birds whereas improved birds are kept by 3% of units with an average of 103.71 birds and in this 'commercial' subsector broilers are about 2.5 times as numerous as layers. Ducks are owned by 3% of households with an average flock size of 3.95 birds and pigeons are owned by 5% of household who each have an average of 8.73 birds. More than 56% of cattle are male whereas 22% of buffalo are male as are 33% of yak, 31% of goat and 34% of sheep (Sherchand, 2001). Among traditional poultry about 13% of birds are males and 87% are females. The annual amount of labour devoted to livestock is 51 days in the Mountains, 73 days in the Hills and 64 days in the Terai (MOAD, 2013; CBS, 2014).

[4] Holdings of less than 0.01355 ha in the Terai or less than 0.01272 ha in the Hills and Mountains under crops are considered landless (CBS, 2013).

Livestock are major features of all farming systems. They are, however, more important in the Hills and Mountains where their numbers greatly exceed those of the Terai (Table 2) and where densities per unit of cultivated land are much higher. Households in the Mountains own 11.8 livestock units, in the Hills 10.3 units and in the Terai 5.0 units. More than 60% of buffalo, 50% of cattle, 57% of goats, 43% of sheep and 61% of pigs in addition to 73% of poultry are located in the Hills (MOAD, 2013). High numbers of animals here result in substantial feed deficits, especially during the winter period. At this time of the year animal feed derives mainly from stored crop residues (see, for example, Figure 2d which shows maize stover stored in trees) which provide 16% of total livestock feed and which are distributed to animals around the house compound. In the initial phases of the 'green revolution' rice varieties with short straw were rejected by farmers in favour of the traditional long-straw types which provided more livestock feed (Shrestha, R. K. 1988). In spite of government incentives uptake of higher yielding varieties has continued to be low and the ''most popular varieties were those not recommended by science and policy and were disseminated farmer to farmer'' (Uprety, 2016 pvi): Nepal is still a net importer of rice (Bishwajit *et al.*, 2013).

Small farm mixed systems reveal great complexity (Devendra and Thomas, 2002; Devendra *et al.*, 2005). Interactions among crops, forest and livestock (Figure 3), include:

- holdings are small and fragmented;
- several animal species are kept and many crop types are grown;
- on and off farm including forest resources are used;

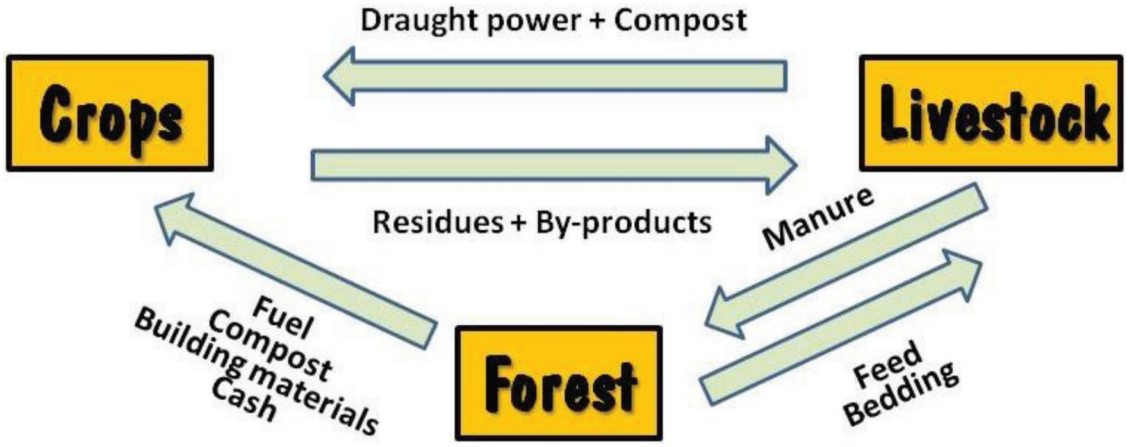

Figure 3: Main component interactions of small farm systems in Nepal

- livestock feed resources are sourced from on and off the farm;
- people have little education;
- there is poor access to services and low use of technology and inputs;
- farms are isolated and far from markets;
- production is diversified as a strategy for risk reduction;
- there is little or no desire (nor much incentive) to maximize production; and
- production is mainly subsistence oriented.

Risk avoidance strategies add to the problems faced by livestock themselves: for example, reduced crop yields and smaller cropped areas drive people to seek outside or migratory labour opportunities. Feed supplies, almost always limited in quantity and quality, are put under pressure. Traditional skills with regard to crop mix, crop varieties, planting dates and pest control are no longer adequate to cope with new problems created by climate change (heavy rains, prolonged droughts and reduced yields due to temperature effects) and high human population densities and resultant overstocking with livestock (Sujakhu *et al.*, 2016). Nutritional inadequacies are linked with health problems, especially general debility caused by internal and external parasites and endemic subclinical disease (Rai *et al.*, 2000; Pradahang *et al.*, 2015): some parasites and diseases are also zoonoses (Devleesschauwer *et al.*, 2013; 2014), and have serious deleterious effects on people and on their ability to work.

Stock rely on residues (rice straw, maize and millet stover, stubbles) and by-products (rice husks, maize cobs, cereal brans, oil seed cakes, molasses) from rainfed and irrigated areas for much of their feed (Upreti and Shrestha, 2006). These resources, especially during the dry winter, are dietary mainstays. Even in systems where crossbred dairy cows are important less than 50% of total feed is fresh green material, much of which is garnered from weeds, field bunds and roadsides. Limited amounts of grown fodder include berseem (*Trifolium alexandrinum*) and leucaena (*Leucaena leucocephala*) (York, 2010) that are fed mainly in cut-and-carry systems. Crop land resources are complemented by limited grazing off it and further cut-and-carried grass and tree forage from surrounding (often distant) scrub and forest areas. There are almost constant shortages of feed because animal numbers are not matched to feed availability and stocking rates grossly exceed carrying capacities in most areas. Farmers therefore need to make choices regarding the priority of providing adequate feed to certain classes of 'productive' stock or feeding all classes at submaintenance (and no production) levels for most of the year (Gatenby *et al.* 1989).

3. Animal Genetic Resources

Farmers own few animals but several species (Shrestha, R. K. 1988; Wilson, 1996). Emphasis on one or other type of livestock depends on preference, social position, local ecology and market openings. Herding many species is a rational strategy for reducing risk but creates management problems and limits output of single products. Livestock belong to at least 17 biodiverse species, most comprising several 'breeds' (Table 3) (Epstein, 1977; Wilson, 1996; MOAC, 2004). There is as yet, however, no detailed 'catalogue' of breeds or types.

Livestock functions in Nepali farming systems are far more complex than the simple provision of milk and meat for human subsistence (Wilson, 1994). Such functions, several of which are intimately related to a sustainable farming system, can probably best be assigned to three major categories, defined as Immediate, Intermediate and Indeterminate (Table 4).

There has been little attempt to characterize Nepali livestock other than on morphological, functional or locational grounds. Little that is objective can, therefore, be said about their potential. In goats and sheep, for example, four breeds are recognized related to a general agroecological zone and production system (Table 5). Indigenous cattle and buffalo are preferred by most farmers because of better adaptability across agro-climatic zones, ability to digest low-quality feeds and to survive on a low nutritional plane, cold tolerance and smaller body size (Paudel, n.d.): local animals also have better resistance to local diseases and to internal and external parasites. The three indigenous pig breeds constitute 58% of the total pig population and are important to Nepal's rich biodiversity of livestock resources but risk extinction because of official policy to replace them with exotic and supposedly 'improved' animals (Nidup *et al.*, 2010). Most native fowl are ascribed to 'sakini' (although Ghanti Khuile and Puwakh ulte are sometimes mentioned) but cursory inspection of a district flock shows many variations -- some normal, some with bare neck

Table 3: Domestic livestock species and indigenous breeds in use in Nepal

Ruminants		Non ruminants	
Species	**Breeds**	**Species**	**Breeds**
Buffalo	Lime, Parkote, Gaddi	Pig	Chwanche, Hurrah, Bampudke
Cattle	Terai, Lulu, Achhami, Pahadi, Khailla	Horse	Tuli
Goat	Terai, Khari, Sinhal, Chyangra	Donkey	(+ Mule)
Sheep	Lampuchhre, Kage, Baruwal, Bhyanglung	Rabbit	
Yak	(+ plus Yak-Cattle crosses)	Elephant	
		Domestic fowl (''chicken'')	Sakini, Puwankh Ulte (Dumse), Ghanti Khuile
		Other poultry (Pigeon, Common duck, Muscovy duck, Chinese goose, Guinea fowl, Turkey)	

Source: Compiled by the author from Epstein, 1977; Wilson, 1996; MOAC, 2004

Table 4: Immediate, Intermediate and Indeterminate products of Nepali livestock

Immediate	Intermediate	Indeterminate
milk	farm draught power	reduction and spread of risk from crop operations
meat	on and off farm transport	generation and accumulation of capital
eggs	industrial applications (oil mills, etc)	generation of income and smoothing out cash flow
fibre	manure as fertilizer	fulfilling social, cultural and religious needs and obligations
hides and skins	dung as fuel and for biogas production	providing status or "prestige" in the immediate community
feathers	weed control	empowering women (control of milk sales, sale of eggs to provide cash income)
		culture, sport, recreation and companionship

Source: Compiled by the author

Table 5: Distribution and management of goat and sheep breeds in Nepal

Goat		Sheep		Physiographic region	Altitude (m)	Climate	Management system
Breed	**Per cent of total**	**Breed**	**Per cent of total**				
Chyangra	6.0	Bhanglung	4.0	Mountain	> 2500	Cool temperate/ subalpine	Sedentary/ transhumant
Sinhal[a)]	35.0	Baruwal	41.0	Mountain	> 2500	Cool temperate/ subalpine	Transhumant
Sinhal		Baruwal	22.0	Mid Hill	1500-2500	Warm temperate	Transhumant
Khare	50.0	Kagi	21.0	Lower Hill	300-1500	Subtropical	Sedentary
Terai	9.0	Lampuchre	12.0	Terai	< 300	Subtropical/ tropical	Sedentary

Note: a) The figure of 35% for Sinhal goat is the combined percentage in both physiographic regions.
Source: MOAD, 2013 plus author's analysis

and some with frizzle feather genes -- all of which are likely to have their own production and adaptability characteristics (Shrestha, 2014). Outside the main urban areas scavenging indigenous poultry – which comprise 58% of the total poultry population – are preferred because they require little attention and do not require the expensive buildings feed and veterinary care of modern breeds (Kattel, 2016). There is an undoubted need to conserve some of these resources but it must be remembered that 'conservation' includes preservation and use and there should be no intention of creating a living museum.

Domestic livestock are rarely kept for a single production objective and adaptation to the local environment is an important function. General remarks in some reports about livestock productivity being limited by their genetic potential (eg IFAD, 1990) are neither meaningful nor helpful. Increased productivity, because of the multiple role in the economy and in family life, is part of a complex process. It will not necessarily derive from 'upgrading' and 'improving' of native stock by crossing with supposedly superior exotics. Nor will it be easy to upgrade animals to yield more or better-quality manure, a product often stated to be a main purpose of keeping livestock in Nepal. Improved productivity in the short to medium term is more likely to stem directly from improved nutrition, health and management.

Table 6: Summary of research publications in Nepal by species and subject area

Livestock species	Subject area (number of pages)				Total
	Health	Nutrition	Breeding	Production and management	
Cattle, buffalo and yak	40	19	28	31	118
Goat and sheep	20	12	18	21	71
Pig	4	3	8	8	23
Poultry	11	10	2	12	35
Rabbit	1	2	0	6	9
Total	76	46	56	78	256

Source: compiled by the Author from Tiwari *et al.*, 2011

This does not mean that ways to improve the inherent value of local types should not be sought concurrently and that characterization should not be a major element of the process. In pursuing this policy, however, consideration must be given to comparative advantage and economics. If, for example, India produces animals for socio-economic and ecological conditions similar to those of Nepal, what is needed is adaptive research on these animals to determine their suitability. Similarly, if it is cheaper to import wool for the carpet industry from New Zealand than to produce it locally, research effort should concentrate on something in which Nepal has comparative advantage.

4. Research

A great deal of research has been undertaken on the domestic livestock of Nepal. A compendium of documents published in Nepal in the 30-year period 1980-2010 (Tiwari *et al.*, 2011) shows that most work was on bovines, most was on health and disease problems (Table 6), most was on very few animals and of very short duration and most was of an *ad hoc* nature[5].

Indigenous domestic livestock have received little respect or consideration from research and development bodies in Nepal although there was some interest in their use and conservation during the 1990s and early 2000s (Sah and Joshi, 2003). The apparent policy – in large part driven by international donors and non-Governmental Organizations – has usually been to upgrade and replace native stock by 'improved' breeds. In the early twenty-first century the Department of Livestock Services of the Ministry of Agriculture and Cooperatives had 11 farms undertaking research and the National Agricultural Research Council had nine (MOAC, 2004): the main thrusts of research, without exception on all of these farms) was were on exotic breeds and replacement of indigenous ones.

Official policy – if indeed 'policy' is the correct word – for buffalo has been to upgrade and replace local varieties by crossing to Murrah bulls by natural mating or by Artificial Insemination (AI). Jersey and Holstein-Friesians are the main exotic cattle breeds with most recent imports being from India. Semen of these, and of Ayrshire and Brown Swiss, is nominally available via an AI service. Except in accessible pockets, however, there has been little success with AI and the impact on native stock has been minimal. Only 2-5% of the livestock population has been touched by these programmes. In the late 1980s there were 117 AI centres in 34 of the country's 75 districts, 71 being in the Hills, 43 in the Terai and only 3 in the Mountains. Most semen was then imported from India. In 1989, 2951 doses of frozen and 4319 of 'warm' semen were available and 60% of this was distributed to the Terai. Only 20% of the semen was used and the average number of inseminations per month (cattle and buffalo combined) was less than eight. Conception rates were about 30% to first service. Animals thus still need to be inseminated several times and farmers usually quickly revert to natural service (ADB, 1992; York, 2010). In 2004 the uptake of AI was still less than 1% (Shrestha, 2004) and there is still no evidence in support of productivity being improved through genetic improvement of dairy animals. Increases in total milk production can be attributed to increases in the number of animals (Paudel and Shah, 2010).

One fashionable and constantly recurring activity is the allocation of a bull to a farmers' group (Gurung *et al.* 1995; Shestha and Amatya, 2004). It has had mixed but usually limited success. A major problem is the cost of keep (in spite of occasional Government subsidy) to a small farmer with limited feed resources. This is compounded by the reluctance of other farmers to pay an economic price for the service fee. Development projects often provide free or highly subsidized exotic cattle in the milk catchment areas of the main urban centres but there is little indication that this process will be sustainable in the long term and following the termination of the projects in question[6]. Government maintains two breeding farms for yak. Numbers are low at both places and a very few animals are distributed to traditional owners each year. Breeding objectives are far from clearly defined and oscillate between pure breeding of yak and crossing with cattle to increase the ecological range of both species for smallholder use. 'Improved' white yak bulls have been imported from Tibet for use in 'upgrading' local animals (Kharel, 1995).

The goat has been subject to the archetypal upgrading and replacement by improved breeds. Breeds have been imported from many parts of the world. Jamunapari, Barbari and Beetal from India have been easiest to obtain and used most in formal breeding programmes. These breeds, especially the Jamunapari, are widely used by Terai smallholders. There is evidence of Saanen blood but it is not clear whence this came. Semen of Kiko (a New Zealand breed developed from feral goats for

[5] The compendium does not cover any research published outside Nepal by Nepali scientists nor does it include the limited number of articles published outside Nepal by international scientists.

[6] Formal support for dairy production, processing and marketing began in the early 1950s: there has since been continual, continued and continuing support in the form of technical assistance and financing from *inter alia* the UK, USA, Denmark, Switzerland, New Zealand and the World Bank, FAO, International Fund for Agricultural Development, Asian Development Bank as well as several International NGOs.

meat production from marginal areas) was imported by a UK aid project in 1989. As for other species, the presumption -- with no prior characterization -- has been that native goats need improving. In limited performance trials and in outreach programmes in farmers' flocks the native Khare has usually done as well as or better than its crosses with exotics (Neopane and Upreti, 2001). This is especially so in the composite trait of weight of kid weaned per female per year. The superiority is due to prolificacy, short parturition intervals and low mortality rates. Early maturity, while not measured in the composite trait, probably adds further to the superiority of the Khare. Formal programmes have had limited impact on local genetic resources. In the Terai, however, crossing of Indian with Nepali breeds is common practice among farmers and successful in terms of farmer acceptance. The breed most at risk is the Sinhal which is also crossed indiscriminately with the Khare in the higher Hills/lower Mountains. A small flock of Sinhal maintained at the Bandipur Goat Farm was perhaps the earliest – if temporally belated – official recognition that this breed was in danger and in need of conservation (Wilson, 1996).

Historically the conventional wisdom has been that Nepalese sheep are of low productivity and poor genetic potential (Pradhan, S.L. 1992). This mindset prevailed to some extent through the next 10 years (MOAC, 2004) and indeed has continued almost up to the present (Pradhanang *et al.* 2015). Official policy has been to improve native populations by crossing with exotics. Both wool (for the national carpet industry for which almost all wool is imported) and meat production are cited as goals. Introduced breeds have been brought from afar. The favourites have been Polwarth and other Merinos, including Merino d'Arles, Rambouillet and milk types. Performance of first crosses has usually been poor: wool yields have been raised under station conditions but reproductive rates have been low with less than 0.5 lambs per ewe weaned per annum. For meat, purebred Baruwal weaned 8.8 kg/ewe/year compared to 5.8-7.9 kg/ewe/year for crossbreds. Four Government sheep farms continue to import and cross exotic sheep on local types and some Romney Marsh and Leicester rams arrived from New Zealand in 1994 to reinforce the policy and a further batch of Romney Marsh and Kuport sheep were imported in 2014 (NMN, 2014). Outreach activities still stress the advantages of crossbreds in spite of much evidence to the contrary (Shrestha, 2006; Acharya *et al.* 2016). These endeavours are, however, very limited in scope both in terms of areas covered and numbers of animals distributed. The general extension service is poorly staffed and lacks the means of access to wider areas. With the exception of a few pockets close to breeding centres there has therefore been little impact on native sheep populations. There is, nonetheless, a real need for proper characterization of indigenous breeds which should be accompanied by at least a temporary halt to the unstructured programmes currently in vogue. There could then follow a more objective national sheep breeding programme within the framework of clearly defined national goals.

The domestic pig programme is based uniquely on exotic breeds. Two or more of these are crossed to produce types considered suitable for various Nepalese environments. The Pakhribas, bred in part to satisfy a local cultural need, is a case in point. Official policy is absorption and replacement of indigenous pigs by natural mating with improved (i.e. exotic) boars distributed by Government farms. The Large White (Yorkshire) and several Landrace starins are the most popular breeds but some Duroc have been imported from Malaysia (Kayastha 2006). Most pigs that leave Government farms are, however, reared for slaughter and not used for breeding by smallholder farmers. Even when used for breeding there is no effective support or monitoring by Government. Except in the Pakhribas command area, where as much as 15% of the village pig population is of the Pakhribas type, pig breeding and improvement programmes have had little impact (Joshi, 2008).

A very few donkeys have been imported from India and Tibet in the past for mule production (Pradhan, S. M. 1992). Tibetan jacks were considered better as they were bigger and better able to mount horse mares. The Government of China also made a gift of 15 male donkeys in 1983. In effect, however, there are no organized breeding or conservation programmes and little to no official interest in equine development or conservation.

The usual 'improvement' package applies to scavenging chickens. Replacement and crossbreeding is based on multiplying layer lines -- New Hampshire, Black Australorp and White Leghorn -- on Government farms. Pakhribas breeds the Indian Giriraja (= Mountain King, a synthetic derived from Rhode Island Red and White Wyandotte) for the scavenging system, ostensibly due to disease resistance. It is liked by farmers for its colour variety but large size (cocks 6 kg, hens 4+ kg) may be a disadvantage in extensive systems. As many as 250,000 birds annually have been distributed to smallholders but the programme's impact has been insignificant. There is no Government follow up to distribution and exotic or crossbred birds are not usually given better feeding, health care or management than local ones. Farmers generally show little interest in supposedly better poultry: in the Pakhribas command area only 1.4% of birds were considered to be cross or pure-bred exotics, a figure that should be compared with 15% of improved pigs in the same area (Shrestha, 2014).

The lack of change in native chicken populations does not apply to urban and peri-urban areas. Where there is a strong and assured market for meat and eggs change has occurred. There are an estimated 15,000 small commercial units of up to 400 layers each and other small broiler units near Kathmandu and Pokhara. Some private hatcheries import parent stock from the USA and Europe and supply sexed day olds to smaller producers. Under good Nepalese management hen-housed averages are 190-260 eggs/bird/12-month cycle for layers and 1600 g at seven weeks for broilers. There is vertical integration in units which mix their own feed, use AI for breeding, rear their own birds and have their own market channels and outlets. Most eggs and birds in Kathmandu, except for sacrificial and festival occasions, are supplied from small or large commercial units (Acharya and Kaphle, 2014).

Eight Government fish farms should breed ducks to supply farmers and to develop integrated duck fish systems. In 1994 only one farm produced ducks (the Khaki Campbell was abandoned after two years as farmers had no interest in its light weight and supposedly superior egg laying). Reduced mature weights and annual

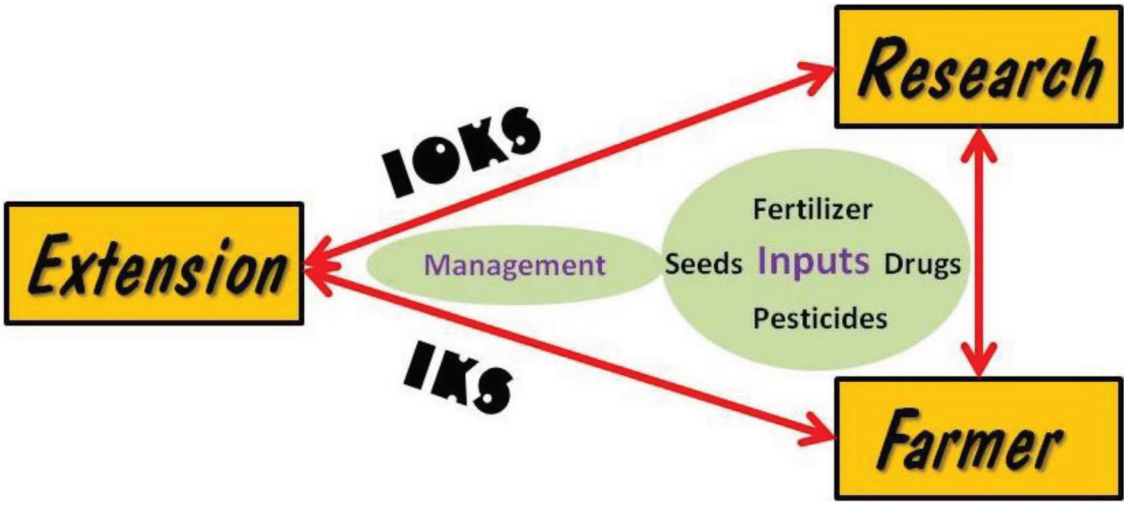

Figure 4: A model of research-extension-farmer linkages in an agricultural knowledge system

egg output of 60 eggs (against 140-150 just after import) on Government farms are considered due to lack of new blood and consequent inbreeding. There are no programmes for other avian species.

5. The Way Forward

There is evidence of a change in thinking in the research and development establishments, for example: "It will be very useful to strengthen and consolidate the participatory approach (PVS and PVB) by broadening that participation in our endeavors [through the] Outreach sites of NARC [which] are the focal points where the extension program and farmers interface with research" and "I would like to call on development supporters and colleagues to place the beneficiaries at the center of their activities. This will also be NARC's approach in framing our research and development strategies." (Sapkota, 2001, pp1-2).[7] Research is, nonetheless, still carried out mainly on station and some of this is still related more to researchers' interests than to real and farmer-identified problems. There is, however, following Sapkota's policy statement more openness and a willingness to work more closely with farmers.

Remaining problems include limited highly qualified manpower (although this situation is changing almost daily) and extremely limited material and financial resources (which may not change as rapidly as desirable in the foreseeable future).

Research in the past was along classic lines: scientists perceived a problem and attempted to solve it under controlled conditions on a research station. There was little to no interaction with the extension services, certainly no appreciation of farmers' problems or needs, and no testing of 'solutions' under the real-life conditions of small, fragmented and resource-poor Nepali farms. If production objectives have been defined -- and this has rarely been the case - they may possibly have been of a general nature such as the production of a buffalo cow that might produce 900 litres of milk in 305 days. The objectives have assumed that management would be of a reasonable standard, that a balanced and sufficient diet would be fed and that there would be good health coverage. Production objectives must now be redefined to something such as 'to produce a buffalo cow capable of a lactation yield of 900 litres of milk in 305 days under farm conditions where management is of a low standard, where there is a variable feed supply, where adequate veterinary care is not available and where the absence of males for long periods might lead to late ages at first parturition and long intervals between parturitions'.

Future research must take account of these lessons. Farmers are neither peripheral to nor divorceable from research. Nor are they simple clients but an integral part and a full partner in the research and development complex (Figure 4). Research-extension-farmer linkages are essential whatever the level of intensity. They become even more important as productivity improves. Men and women farmers (Bajracharya, 1994) are an integral, indeed a key, part of the Research-Extension-Farmer triangle. Knowledge flows in all directions and all parts of the knowledge system (indigenous knowledge system IKS of farmers and indigenous organized knowledge system IOKS of scientists) must be aware of and appreciate the skills of the others. Only by using this methodology will farmers benefit technically and economically from the results of research and will scientists achieve intellectual satisfaction.

The potential opportunities for improving livestock production in Nepal appear to lie in:

- training of farmers to improve management skills;
- manipulating input/output ratios;
- optimum use of land and livestock;
- use of improved and adapted technology;
- strengthened and integrated support services; and
- appropriate institutional and policy issues.

Taking into consideration these points and the limited resources available to Nepal, future research should be carried out:

> **on station** applied and adaptive research on relevant themes from areas with similar socio-economic and agroecological environments; and

> **on farm** adaptive research and on-farm technology testing (OFTT) of relevant interventions in partnership with farmers.

Some possible relevant technologies for OFTT (in no way exclusive or restrictive but which take account of

[7] R.P. Sapkota was Executive Director of the National Agricultural Research Council at the time.

many of the real constraints to improved productivity including the major seasonal feed shortages) might include the effects of:

- readily available rumen protein and energy (UMB) on weight gain of weaned goats;
- nutrition in late pregnancy on fertility, birth weight and kid mortality in goats;
- protein and energy (UMB) supplements on milk production of buffalo;
- early nutrition on age of buffalo at first conception; and
- use of cold-brooder boxes on chick growth and survival to egg-laying.

Long term political unrest, weak programmes and policies and especially weak agricultural education, research and extension services have contributed to the fluctuating and slow pace of agricultural development. In the past agricultural extension services were essentially top-down. Educational programmes and services were planned at the Department of Agriculture or Department of Livestock Services headquarters. Most extension activities are now planned at district level and private sector organizations, NGOs and professional associations (such as the Nepal Agriculture Extension Association (NAEA) established in 1990) complement public sector interventions. This system of linkages is being encouraged for efficient delivery of agricultural services. Public-private partnerships are being promoted and in addition to public provision NGOs and Community Based Organizations (CBOs) are contributing to the education and training of farmers. Information and Communications Technology (ICT) tools such as mobile telephones, internet, radio and TV are increasingly available and being used to facilitate communication and enhance rural development. Training of extension workers on participatory services, provision of timely market information to farmers and producers, strengthening supervision of field staff and providing reward and recognition programmes to motivate extension staff to deliver superior work are some of the steps needed to encourage farmers to produce food and to improve their skills (Ganesh Kumar *et al.*, 2003; Garforth, 2004; NARC, 2010; Murari and McNamara, 2011; Sharma, 2011).

About the author

Trevor Wilson is a practical farmer (retired) who bred pedigree Ruby Red Devons for many years. He is also an independent consultant on the environment and agriculture specializing in developing countries and with an emphasis on domestic animal genetic resources and livestock production. He was Director of the International Livestock Research Institute's West African Arid and Semiarid Zones Programme and Research Director of a specialist group at ILRI's headquarters in Addis Ababa, Ethiopia. He spent several periods in Nepal, that experience leading to the writing of this paper.

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