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SHORT COMMUNICATION

ANIMAL BREED DOMESTICATION AND BIODIVERSITY IN AGRICULTURE

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Introduction

Domestication of animals is one of the most purposeful interactions between human and a valued animal. The transformation of a wild animal into livestock resource domestication (ARD) involves the introduction of animal into human-controlled environment (Kerr, 1903, Chang, 2009; Ajayi and Tewe, 1980; Onadeko and Amubode, 2012). It also comprises selection of desired production traits in breeding (Ghigi 1966, Somes 1996) and laboratory animals (Annor *et al.*, 2012a, b). Scientific information is helpful in understanding the process of animal resource domestication. Among them are those studies which are concerned with determining the wild progenitor(s) of modern livestock and their centre(s) of domestication (Loftus *et al.*, 1994; Bradley *et al.*, 1996; Fumihito *et al.*, 1996; Sawai *et al.*, 2010; Hiendleder *et al.*, 1997; Luikart *et al.*, 2001; Joshi *et al.*, 2004; Guiffra *et al.*, 2000). Other auxiliary studies of ARD are those that are centred on the conservation of wild progenitors of modern livestock and their relatives in natural habitats (Shackleton, 1997; Fuller *et al.*, 2000). As a result, it is easy to comprehend the differences in behavioural pattern of wild animals and their domestic form as well as the disparity in their production performance.

Domestication therefore appears as an indirect approach towards sustainable use of animal resources. The taming of wild animals is closely associated with the desire to preserve food resources whose supply are threaten by changes in climatic conditions and expansion in human population (Blummer, 1992; Diamond, 2002). However, the decision to relocate an animal resource to human-controlled environment was based on criteria such as non-aggressive response to humans, adaptability to wide environmental conditions and display of socio-positive behaviour within a population (Hale, 1969; Price, 1999; Kunzl and Sachser, 1999). Afterwards, production traits such as fast growth rate and higher body weights are selected in successive generations of captive populations resulting in the development of domestic forms (Uchola, 2015). In this way, Animal Resource Domestication (ARD) becomes the pathway to sustainable production of animal products and in the process displaced hunting as a major form of production in contemporary society.

The nature of Animal Resource Domestication (ARD) as a process that transforms a wild animal into livestock facilitates the expression of diversity within an animal resource. Several studies have already established ARD with aspects of biodiversity such as those that are centred on wild progenitor(s) of modern livestock (Bradley et al 1996, Fumihito et al 1996, Hiendleder et al, 1997, Luikart et al 2001, Guiffra et al 2000) and conservation of livestock wild relatives (Shackleton 1997, Fuller et al 2000). Nevertheless, the concept of

biodiversity as a consequence of ARD and breed development (BD) calls for attention. More still, similar concept of biodiversity in Natural Resource Conservation accommodates carnivorous birds and dangerous animals (IUCN, 2015 and WWF 2016). It is therefore necessary to explore Animal Resource Domestication (ARD), breed development and their impact on the concept of Biodiversity in Agriculture.

Animal Resource Domestication and Biodiversity

Animal as a Resource

Animals are involved in processes that sustain the environment. They generally facilitate decomposition of organic matter, assist in the pollination of flowering plants and aid in the dispersal of seeds. Furthermore, animals are used as important food resource (Uchola, 2015). This fact suggests that an animal resource occurs naturally in a particular ecological zone or region. The red jungle fowl (*Gallus gallus*) is a common bird resource in Southeast Asia, wild turkey (*Meleagris gallopavo*) is a native bird resource in North America while common ostrich (*Struthio camelus*) is endemic to the savannah region of Africa (IUCN, 2015). Likewise, wild goat (*Capra aegagrus)* is a known herbivore whose habitat extends across the Indian subcontinent, wild sheep (*Ovis orientalis)* roam freely across Eurasia just as the wild cattle (*Bos gaurus*) inhabit parts of Asia.

In natural habitat, an animal resource partially expresses its production potentials. The partial expression of production ability often takes different forms such as slow growth and low productivity. It may be difficult to describe growth pattern of wild progenitors of modern livestock as data are scare. Nevertheless, the growth and productivity of an animal resource may be inferred by considering the production performances of its closest domestic form. For instance, some local chicken ecotypes that were reared in artificial environments and feed with formulated diets grow to about 300g within the first 8 weeks (Binda *et al*., 2012). In addition, the birds consumed over 3g of feeds to gain 1g of body weight. This is an indication that the growth pattern of jungle fowl and meat yield would be even lower given the negative effects of extreme climatic conditions and biotic stress. Furthermore, native ecotypes with body weight gained–BWT (<300g) and Food Conversion Ratio–FRC (>3.0) when compared to improved meat breeds with BWT (>1200g) and FCR (<2.5) reveal that partially domesticated or wild form of chicken are less productive. Based on this suggestion, red jungle fowl provided about one-quarter of the meat supplied by some chicken meat breeds.

Exploitation affects the population status of an animal resource. Continuous exploitation of wild turkey *(Meleagris gallopavo)* up to the mid 20th century lead to a rapid decline of its population (Alldredge *et al*., 2014). Presently, the situation has changed for the better as the bird's population is increasing due to new and effective management measures (IUCN 2015). However, the situation is different for other animals like ostriches (*Struthio camelus*) and wild goats (*Capra aegagrus*) whose population is still on a decline. To control the threats of extinction, natural populations are increasingly being protected through scientific studies and establishment of National parks (Shackleton, 1997; Fuller 2000). Prior to the application of modern conservation measures, animal resources were relocated to artificial environments in an attempt to protect dwindling supply occasioned by fluctuations in climatic conditions and expansion in human population (Diamond, 2002 and Diamond and Bell, 2002). This simple step becomes the foundation for the development of

livestock and their large scale production. In this way, introduction of an animal resource into human-controlled environments becomes an indirect approach towards its conservation.

Animal Resource Domestication

Domestication of an animal resource may be viewed as a complex interaction between humans and the animal. It entails improvement of production performances in a native animal after its relocation to human-controlled environments as demonstrated by the different aspects of domestication in the quail and cane rat (Kerr, 1903; Marks 1996; Onadeko and Amubode, 2002; Annor *et al*., 2012a, b).

The introduction of an animal resource into human-controlled environments is a first step in the complex process of transforming wild animals into livestock. The Japanese quail was transferred from its native range in Southeast Asia into cages in different parts of the world while guinea pigs were captured from their natural habitat in the Andes region of South America and reared in confined conditions (Kerr, 1903; Kunzl and Sachser, 1999; Kunzl *et al.*, 2003; Chang *et al*., 2009). These examples are indicative of how other animal resources such as wild cattle, goat, sheep, pig and jungle fowl were transferred from their natural habitats into human-controlled environments. This fact is attested to by genetic evidences which trace the origin of known livestock to wild progenitors (Loftus *et al*., 1994; Bradley *et al*., 1996; Fumihito *et al*., 1996; Hiendleder *et al.*, 1998; Luikart *et al*., 2001; Guiffra *et al*., 2000; Joshi *et al*., 2004; Sawai *et al*., 2010) as shown in Table 1.

Selection of production traits in established populations of a captive animal resource is the next phase of its domestication. In captive-bred guinea fowl whose plumage colour is dark grey-black ground dotted with white spots, series of selection produced individuals with distinct plumage colour-type including pearl, white and dun (Ghigi, 1966; Somes 1996). In like manner, selection for tameness in successive generations of captive-reared guinea pigs produced individuals with a more socio-positive behaviour towards other members of the same populations which made them more disposed to courtship and sexual activities (Kunzl and Sachser, 1999; Kunzl *et al*., 2003). Artificial selection has also been used to demonstrate the possibility of improving body weights and other growth-related traits in population of captive cane rat (Annor *et al*., 2012a, b). These examples suggest that artificial selection generally explores the production potentials of a resource which is made visible through variations in individuals of the same population. Therefore, successful selections of production traits during the domestication process transform primitive resources into highly productive domestic animals.

Domestication processes therefore facilitate better trait expression in an animal resource. For example, the artificial selection of Japanese quail improved the meat yield from about 100g in the earliest domesticates to about 300g in modern populations (Anthony *et al*., 1996; Marks, 1996). Generally, comparison of the production performance of an animal resource and its domestic form is a great challenge to this effort due to scarcity of data. Nevertheless, the effect of domestication on productivity of an animal resource may be inferred by considering the improvements in the production performance of their closest domestic forms. For instance, milk production of local cattle breed increase as a response to increases in the degree of improvement (Buvanendran *et al.*, 1981). Ogundipe and Adeoye, 2013 reported a comparison of milk yield estimate of local breed (<900kg) and pure breed

(>2000kg) within the same period; which reveals that artificial selection for milk yield in cattle increased production several times.

Table 1: Selected wild animals and their domestic form

Wild Animals	Genus	Species Estimate & Main Species	Wild Progenitors	Domestic Form
[1]Jungle fowl	*Gallus*	4 main species *Gallus gallus* *G. lafeyettei* *G. sonneratii* *G. varius*	Sub-species of *Gallus gallus* in different locations	*Gallus domesticus*
[2]Pig	*Sus*	1 main species *Sus scrofa*	Sub species of *Sus scrofa* in the different regions	*Sus scrofa domesticus*
[3]Goat	*Capra*	9 main species *Capra aegagrus* *C. caucasica* *C. cylindricornis* *C. falconeri* *C. ibex* *C. nubiana* *C. pyrenaica* *C. sibirica* *C. walie*	*C. aegagrus*	*Capra hircus*
[4]Sheep	*Ovis*	6 main species *Ovis ammon* *O. canadensis* *O. dalli* *O. orientalis* *O. nivicola* *O. vignei*	*Ovis orientalis*	*Ovis aries*
[5]Cattle	*Bos*	5 main species *Bos gaurus,* *B. javanicus* *B. mutus,* *B. primigenius* *B. sauveli*	*B.p. primigenius* + *B.p.opisthonomous* *B.p. nomadicus*	*Bos Taurus* *Bos indicus*

[1]Fumihito *et al*., 1996, Sawai *et al*., 2010, IUCN, 2015; [2]Guiffra *et al*., 2000, IUCN, 2015; [3]Luikart *et al*., 2001, Joshi *et al*., 2004, IUCN, 2015; [4]Hiendleder *et al*., 1998; IUCN, 2015; [5]Loftus *et al*., 1994; Bradley *et al*., 1996; IUCN, 2015

Impact of ARD and BD on the concept of biodiversity

Domestication of an animal may be interpreted as the first step in the development of future distinct breeds. For example, selection in successive generations of captive jungle fowl resulted in the domestic chicken (*Gallus domesticus*) while further selection for preferred production traits produce several of its breeds (FAO, 2002; FAO, 2007). Also, Breed Development (BD) visibly expands the diversity within a livestock. For instance, there are hundreds of cattle breeds and tens of sheep breeds as in Table 2. Thus, a new relationship is established in the course of transforming an animal resource into a livestock and a livestock into several breeds.

Table 2: Selected Livestock and their biodiversity (Wild fauna and breeds/Hybrids)

Livestock	Wild Progenitor	Wild Fauna	Livestock Diversity* (Estimated & Selected Examples)
Chicken *Gallus domesticus*	*Gallus gallus* [1]	*Gallus gallus* [2] *G. lafeyettei* *G. sonneratii* *G. varius*	101 [3] [4] Amrock, Australorp, Baladi Beheri, Bresse, Campine, Crevecoeur, Derbyshire Redcap, Dokki, Dresdener , Faverolles, Fayoumi, Gournay, Hamburgs, Hampshire, Jersey Giant, La Fleche, Minorca, NewHampshire, Orloff, Orpington, Plymouth Rock, Rhodebar, Sussex, Vorwerk, Warren, Wyandotte
Pig *Sus scrofa domesticus*	*Sus scrofa* [1]	*Sus scrofa* [2]	33 [3] [4] Alentejana, American Berkshire, Berkshire, Chester White, Dalland, Duroc, Ghori, Haitian, Jersey Red, Lacombe, Large Black, Large White, Mangalitsa, Meishan, North Caucasus, Pelon, Pietrain, Saddleback, Seghers, Siska, Spotted, Tamworth, Turopolje, Welsh, Wessex Saddleback.
Goat *Capra hircus*	*Capra aegagrus* [1]	*Capra aegagrus* [2] *C. caucasica* *C. cylindricornis* *C. falconeri* *C. ibex* *C. nubiana* *C. pyrenaica* *C. sibirica*	40 [3] [4] Anglo-Nubian , Angora, , Barbari, Bengal, Berber, Boer, Dutch Pied, Gaddi, Granada, Kalahari, Kamori, Karachai, Maradi, Maure, Murciana, Nigerian Dwarf, Oberhasli, Peacock Goat, Poitou, Saanen, Sahelian, Somali, Toggenburg, Tswana, Verata.

		C. walie	
Sheep *Ovis aries*	*Ovis orientalis* [1]	*Ovis ammon* [2] *O. canadensis* *O. dalli* *O. orientalis* *O. nivicola* *O. vignei*	100 [3] [4] Australian Merino, Awassi, Blue Texel, Bond , British Milksheep, Chios, Coopworth, Corriedale, Devon Longwool, Dormer, Dorper, Dorset, Dorset Down, Drysdale, Finnsheep, North Ronaldsay, Quessant, Pool Merino, Polwarth, Polypay, Portland, Santa Cruz, Texel, Van Rooy, West African Dwarf, Zwartbles .
Cattle *Bos taurus* *Bos indicus*	*B.p. primigenius* + [1] *B.p.opisthonomous* *B.p. nomadicus*	*Bos gaurus* [2] *B. javanicus* *B. mutus*, *B. primigenius* *B. sauveli*	112 [3] [4] Aberdeen Angus, Ayrshire, Braford, Brahman, Brown Swiss, Charolais, Chusco, Creole, Devon, Dexter, Galloway, Gascon, Gelbvieh, Goudali, Guersney, Hereford, Holstein, Limousin, Lincoln Red, Muturu, Ndama, Normande, Red Angus, Senepol, Sokoto Gudali, White fulani.

*Trans-boundary Breeds/Hybrids
Chicken [1] Fumihito *et al*., 1996; Sawai *et al*., 2010; [2] IUCN, 2015; [3] FAO, 2007; [4] FAO, 2002.
Pig [1] Guiffra *et al*., 2000; [2] IUCN, 2015; [3]FAO, 2007; [4] FAO, 2002.
Goat [1] Luikart *et al*., 2001; Joshi *et al*., 2004; [2] IUCN, 2015; [3] FAO, 2007; [4] FAO, 2002.
Sheep [1] Hiendleder *et al*., 1997, [2]IUCN, 2015; [3] FAO 2007; [4] FAO, 2002.
Cattle [1] Loftus *et al*., 1994; Bradley *et al*., 1996; [2] IUCN, 2015; [3] FAO, 2007; [4] FAO 2002.

The Jungle fowl (*Gallus gallus*) and the other *Galus* species play an important role in processes that sustain their environment and serve as a source of food for indigenous people. The domestic chicken, whose transition from the wild state begins with a relocation of jungle fowl from its natural habitat, is the most advanced form of jungle fowl even though the jungle fowl continues to be an integral part of the ecosystem and a food resource for humans. Put differently, jungle fowl and other *Gallus* species are less developed in relation to domestic chicken. Accordingly, jungle fowl and other *Gallus* species constitute the wild fauna of domestic chicken (Table 2). In addition, the emergence of breed of domestic chicken through its response to further selection pressures is an expression of a diversity that is inherent within the animal. Therefore, the sum of chicken breeds and its wild fauna would constitute the biodiversity of domestic chicken. Likewise, the sum of a livestock breed and its wild fauna represents the biodiversity of that particular livestock.

The description of wild fauna based on Animal Resource Domestication (ARD) suggests it is a synonym for wild relatives of domestic animals. However, a concept of biodiversity that is derived from ARD and breed development (BD) encompasses wild

fauna of a livestock and its breeds. Therefore, biodiversity as a concept in agriculture is confined to a particular livestock since it captures the different levels of an animal development, i.e., from the wild fauna of domestic chicken, through its earliest domestic form and then to the modern breeds.

The ARD-based concept of biodiversity does not include animals that are unrelated to a particular livestock. For instance, the biodiversity of cattle includes wild fauna of cattle but exclude similar large ruminants such as Africa buffalo (*Syncerus caffer*) which fatally attack humans and North American Bison (*Bison bison*) whose domestication has largely been unsuccessful. Similarly, the wild fauna of domestic chicken comprise all *Galus* species but not bald eagle (*Haliacetus leucocephalus*) or American white pelican (*Pelecanus erythrorhunchos*) both of which are not related to any poultry. This point of departure in ARD-based concept of biodiversity differentiates it from similar concept, used by conservation-based organisations such as the International Union for the Conservation of Nature (IUCN), which considers animals not related to livestock and other endangered species as integral part of its "biodiversity". A concept of biodiversity that is borne out of the domestication experience gives specific meaning to its generalised form as used by conservation-based organisations.

Conclusion

The study reveals how animal resource domestication (ARD) and breed development (BD) have streamlined the concept of biodiversity into a specific concept which represents the relationship between a livestock, its numerous breeds as well as its wild progenitor and relatives. The experiences of ARD and BD have redefined biodiversity into a concept that is unique to agriculture. Thus, with greater appreciation of the role of ARD, it seems more likely that phrases such as cattle biodiversity, chicken biodiversity, goat biodiversity, pig biodiversity, sheep biodiversity would be used more frequently by the Agriculture professionals and scientists.

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