Current developments related to livestock production in Asian countries

Asian human population has grown big. Over the past half a century, the population in Asia has multiplied by a factor of 2.5 – rising by almost 2.2 billion in absolute numbers and at an average annual pace of over 1.8%. By 2007, over 3.9 billion, roughly 60% of the world population reside in Asia.

The Asian “population explosion” is actually a “health explosion” – fuelled largely by the declining mortality due to dramatic improvements in life expectancy. However, during the last three decades, Asia saw pervasive and dramatic declines in local fertility levels. In fact, absolute growth for the region’s population appears to have peaked: the annual increment in population today is distinctly less than in the late 1980’s and indeed lower than those in the 1960’s (Eberstadt, 2007).

The growth in human population in Asia has also been accompanied by unprecedented economic growth that has allowed increases in income and purchasing power, and changes in food preferences. These recent developments have major impacts on demand for animal-derived products, particularly meat and milk. While the consumption per capita of livestock products is much greater in developed countries, such has fallen slightly over the last decade and substantial growth occurred in developing countries of Asia.

In view of the rise in demand for animal-derived products, against the background of declining land areas for agriculture and feed production, there is increasing commercialization of swine and poultry production. Annual growth in chicken in 2001-2004, for example, is
about three-fold that noted in large ruminants (Table 2). This is so because poultry and swine production is more attractive to private investors in view of faster growth and multiplication, and its inherent efficiency advantage over ruminants in converting quality feedstuffs to edible meat. Of course this development has implications on upward movement in volume of importation of feed grains, which are not abundantly produced in the region. To what extent this can sustain the growth in the non-ruminant animals sector would be largely affected by the availability of feed grains in the international market as well as the prevailing commodity and transport costs. The extent of possible conversion of grain to ethanol in the country of production may have also significant impact on these concerns in the immediate future.

Table 2. Total Livestock Population in Asia (′000 hd)

| Livestock Species | 2001       | 2002       | 2003       | 2004       | Annual Growth, % 2001-2004 |
|-------------------|------------|------------|------------|------------|---------------------------|
| Cattle            | 417,308.8  | 412,620.2  | 414,831.2  | 417,974.8  | -0.16                     |
| Buffalo           | 159,925.9  | 162,063.4  | 164,431.9  | 166,472.5  | 1.34                      |
| Pig               | 537,534.7  | 51,245.6   | 560,496.8  | 568,822.9  | 1.90                      |
| Goat              | 32,422.8   | 441,113.4  | 452,299.8  | 466,201.3  | 2.47                      |
| Chicken*          | 6,611.7    | 7,249.7    | 7,115.2    | 7,398.5    | 3.92                      |

Source: FAO 2006 (million head)

The rise in income among urban population has also brought about a corresponding shift in food preference as demonstrated in the increasing demand for beef and milk. With the reduced land area for grazing and forage production, the only immediate option to meet the growing requirements is increase in imports of milk and beef into the Asian countries in recent years. As a long-term development strategy, however, efforts in fast-growing economies in Asia have also included programs to enhance growth in their respective local dairy industry with massive infusion of dairy stocks from Australia and New Zealand. This development approach is becoming more meaningful in most of the Asian countries that remain net importers of milk and dairy products as prices of milk in the international market have surged in view of the policy and regulatory measures in some exporting countries and also due to unfavorable climatic factors that resulted in reduced production and thus in traded milk in the international market. But with the rising demand for same dairy animals for restocking farms in post-BSE Europe and Latin America, prices of dairy breeder stocks have also significantly increased lately.

As most of the growth in this region occurs in urban areas due to continued migration of people to the cities forming large concentration of consumers in urban communities, this has resulted in increasing commercialization of production in peri-urban areas. These commercial-size livestock operations have created new challenges due to rising concerns on the resulting impact of increased waste and pollutants to the environment.

Likewise, in view of the growing livestock production in the region, there is a heightened awareness on the need to achieve disease-free status to enhance trade in livestock and livestock products.
These recent socio-economic developments seen in most of the growing economies of Asia also have implications on the over-all water buffalo production system in the region.

**Recent Buffalo Population and Production in Asia**

The Asian buffalo and the smallholder farmer are almost synonymous in many respects and have been in tandem for centuries, generating food and agricultural products in the mixed farming system dominant in developing countries of Asia. The number of animals per household range from 1 to 5 in East and Southeast Asia where the buffaloes are of the swamp type and mainly used for draft and secondarily for meat. A similar situation can be seen in South and Southwest Asia where riverine-type buffaloes abound and the primary purpose is for milk and secondary for meat. While majority of these animals are reared in a mixed cut and carry, tethering and grazing system on communal pasture land, maximizing the utilization of crop residues and farm by-products, there are emerging semi-commercial and commercial-size dairy operations around the peri-urban areas that are reared in total confinement system and are fed forages and fed materials raised in some farms and then hauled to the dairy facilities. Dairy cows are kept while in lactation and thereafter are sold to be replenished by pregnant animals derived from village sources. The recent production output in terms of milk, meat, draft and hide, and the growth in population are summarized below together with an enumeration of the currently existing buffalo breeds.

**Buffalo Population and Growth Rates**

Asian buffaloes dominate the world population, representing 96.36% of the worldwide population of 172.2 million as of 2004. Within the Asian region, about 90.7% of buffaloes are in South and Southwest Asia (77.39%) and East Asia (13.38%) (Table 3).

**Table 3. Regional Distribution and Average Annual Growth Rate of Buffalo Population in Asia**

| Region                | Population ('000 hd) | % of Asia | % of World | Growth Rate (2001-2004),% |
|-----------------------|----------------------|-----------|------------|---------------------------|
| Southeast Asia        | 15,331               | 9.20      | 8.89       | 2.68                      |
| South and Southwest Asia | 128,844              | 77.39     | 74.79      | 1.55                      |
| Central Asia          | 9                    | 0.005     | 0.005      | 0                         |
| East Asia             | 22,287               | 13.38     | 12.93      | -0.7                      |
| ASIA                  | 166,472              | 100.00    | 96.63      | 1.34                      |
| WORLD                 | 172,263              | 100.00    | 100.00     | 1.34                      |

Source: FAO Production Yearbook, 2006

During the period 2001 to 2004, the Asian buffalo population registered an average annual population growth rate of 1.34%, with the highest growth occurring in Southeast Asian countries at average annual growth rate of 2.68%. This recorded positive growth in buffalo
population in SEA is interesting considering that this region experienced dramatic decline in inventory in the 1990’s with the massive introduction in farm mechanization and intensive irrigation in rice-producing areas where the water buffaloes are utilized primarily as source of draft power.

Buffalo population distribution in major buffalo producing countries in Asia is presented in Table 4. During the period 1994-2004 a dramatic decline occurred in buffalo population in East and Southeast Asia, except in the Philippines and Myanmar. The decline was quite dramatic in Thailand, a phenomenon that has also been experienced in earlier years by

| Country       | 2004 Population ('000) | % Growth Rate 1994-2004 | Annual Growth Rate in Tractor Usage 1993-2002, % |
|---------------|------------------------|--------------------------|---------------------------------------------|
| East Asia     |                        |                          |                                             |
| China         | 22,287                 | -0.1                     | 4.2                                         |
| Central Asia  |                        |                          |                                             |
| Kazakhstan    | 9                      | -1.7                     | -                                           |
| Southeast Asia|                        |                          |                                             |
| Cambodia      | 625                    | -2.5                     | 12.9                                        |
| Indonesia     | 2,572                  | -3.1                     | 10.4                                        |
| Laos          | 1,111                  | -1.1                     | -2.6                                        |
| Malaysia      | 163                    | -0.4                     | 3.4                                         |
| Myanmar       | 2,65                    | 2.1                      | -2.4                                        |
| Philippines   | 3,27                    | 2.0                      | 0                                           |
| Thailand      | 2                       | -10.0                    | 10.8                                        |
| Timor         | 70                      | 3.5                      | 1.4                                         |
| Vietnam       | 2,869                  | -0.6                     | 22.3                                        |
|               | 15,33                  |                          |                                             |
| South & Southwest Asia |          |                          |                                             |
| Bangladesh    |                        |                          |                                             |
| Bhutan        | 850                    | -3.0                     | 0                                           |
| India         | 2                      | 0.6                      | -                                           |
| Iran          | 97,7                   | 1.1                      | 4.2                                         |
| Nepal         | 560                    | 2.4                      | 1.9                                         |
| Pakistan      | 3,952                  | 2.1                      | -0.7                                        |
| Sri Lanka     | 25,5                   | 2.9                      | 1.3                                         |
|               | 280                    | -12.0                    | 9.7                                         |
| ASIA          | 128,844                |                          |                                             |
| WORLD         | 166,792                | 0.9                      |                                             |
|               | 172,263                | 0.9                      |                                             |

Source: FAO Production Yearbook, 2006
Malaysia and Taiwan. Because of the very intensive agriculture in Taiwan in the 1970’s and 1980’s, small-size farm machineries were used as the primary mode of land tillage and farm transport, with a sizeable number of their buffaloes ending up in the feedlot for fattening and eventually for slaughter. The 360,000 buffaloes in 1960 were reduced to only 4,000 in 2004 and as a result, part of current Taiwan’s genetic conservation program is buffalo germplasm considered to be extinct in the country very soon (Wei & Jea, 2006). The same pattern was noted in Malaysia following the substitution of buffaloes with farm tractors in rice lands and in palm oil plantations in the 1980’s and early 1990’s. Today the role of buffalo in the overall livestock sector in Malaysia is less than 4.0% (Abas et al., 2006).

**Buffalo Milk Production**

The 2004 buffalo milk production in Asia represents 96.37 of the total volumes of 76.67 million MT of the world’s buffalo milk produced for the year or equivalent to 37.74% of all milk in the region. Production in South and Southwest Asia, primarily from India and Pakistan, contributed a hefty 95.96% of the total Asian buffalo milk production. Buffaloes are significant sources of milk in this sub-region, contributing as high as 68.35% of the total milk yield in Pakistan and 56.85% in total milk production in India.

Growth rate in buffalo milk production in Asia was a bit lower during the last three years as compared to the early years of the 1994-2004 period. Similarly, compared to the rest of the world, Asia’s growth rate in 2001 to 2004 was only about 2.8% as against 8.69% (Table 5).

Among the SEA countries, Myanmar registered the highest buffalo milk production, apparently because it has the highest population of dairy buffalo of about 40,000 hd as of 2000.

| Region                | Year    | 1994  | 2001  | 2002  | 2003  | 2004  | 1994/2004 | 2001/2004 |
|----------------------|---------|-------|-------|-------|-------|-------|-----------|-----------|
| Southeast Asia       | 1994    | 129.6 | 150.0 | 154.4 | 158.5 | 162.5 | 2.53      | 2.66      |
| South & Southwest    | 1994    | 46,628| 65,105| 67,103| 69,733| 70,981| 5.2       | 2.86      |
| Central Asia         | 1994    | 2.1   | 2.68  | 2.7   | 2.75  | 2.75  | 3.0       | 0.83      |
| East Asia            | 1994    | 488,857| 67,935| 69,957| 72,64  | 73,893| 4.1       | 2.8       |
| ASIA                 | 1994    | 1,675 | 2,463 | 2,314 | 2,78  | 2,778 | 5.3       | 8.69      |
| OTHERS               | 1994    | 50,532| 70,399| 72,292| 75,421| 76,671| 4.2       | 2.83      |
| WORLD, BUFFALO       | 1994    | 532,357| 589,912| 603,105| 616,105| 618,528| 1.6       | 1.85      |
| WORLD, ALL MILK      | 1994    | 9.49 | 11.93 | 11.98 | 12.24 | 12.39 |           |           |

Source: FAO, 2006
Buffalo milk production from the other SEA countries are coming mainly from smaller population of introduced riverine buffaloes and the resulting crossbreds of the dairy breed with the existing swamp buffalo population. In this sub-region where farmers tend their animals primarily for work, only a small percentage of crossbreds produced are fully utilized for milk production.

**Buffalo Meat Production**

In developing countries of Asia where meat from ruminants constitute only about 21.0% of the total meat production, buffalo meat is about 11.52% of the total meat from ruminants and about 2.7% of all meat produced in the region (Table 6). The average annual growth rate in production in 1994-2004 was 1.3% (FAO, 2006).

### Table 6. Meat Production in Asia, 2004 (‘000 MT)

| Source       | Asia | World | Asia/World % | % of World |
|--------------|------|-------|--------------|------------|
| Buffalo      | 2,886| 3,124 | 92.38        | 1.23       |
| Cattle       | 14,517| 59,153| 24.54        | 23.26      |
| Goat         | 3,067 | 4,37  | 70.18        | 1.72       |
| Sheep        | 4,564 | 8,225 | 55.49        | 3.23       |
| Pig          | 57,162| 100,888| 56.66      | 39.67      |
| Chicken      | 24,45 | 78,559| 31.12        | 30.89      |
| ASIA PACIFIC | 108,611|       | 42.7         |            |
| WORLD        |      | 254,319|            | 100        |

Source: FAO, 2006

About 78.5% of Asian buffalo meat was produced in South and South West Asia with the greater bulk contributed by India and followed by Pakistan. This is easily explained by the fact that these two countries have 74% of the buffalo population in the region. Improvement in buffalo meat yield is attributable to the increasing usage of male calves, which were not fully utilized in the past in the greater part of India, farmers not paying enough attention to rescue the young animals from high mortality before reaching 6 months of age. In recent years, the rising exports of Indian buffalo meat have given enough incentives for small herd farmers to rear these animals and put additional weight prior to slaughter, thereby sustaining the growth in the meat harvest from the Indian buffalo sector. On the average, however, the extraction rate registered among Asian countries is highest in Pakistan, Nepal and China (FAO, 2006).

**Contribution as Draft Animal**

Draft and transport are two of the earliest known usages of buffalo, in addition to milk, meat and hide. In fact, swamp buffalo population in most of Asia, representing about 22.5% of the total Asian buffaloes, are raised by smallholder farmers as source of draft power in the crop dominant mixed production system. Draft animals are very important asset for the poor in developing countries and are highly valued by many communities in rainfed arid...
and semi-arid lands and hilly and mountainous areas. Draft animals permit more land to be cultivated in a timely manner and with less human drudgery. Furthermore, the increasing miniaturization of land holdings in the mixed farming system limits use of expensive farm machineries.

Table 7. Value of Various Products from Buffaloes, Philippines 2002

| Source                  | Value (US$ Million) |
|-------------------------|---------------------|
| Meat                    | 115.32              |
| Hide                    | 10.0                |
| Milk                    | 1.68                |
| Draft                   | 1.48                |
| - Contribution to Rice  | 0.41                |
| - Contribution to Corn  | 0.48                |
| - Contribution to Coconut | 0.32             |
| - Contribution to Sugarcane | 0.25         |

Exchange Rate: 1:50; Source: SIKAP/STRIVE Foundation, 2004

Table 8. Fresh Buffalo Hide Production in Asia 2003

| Sub region            | Volume '000 tons | Growth Rate 2000-2004 | % of Asia |
|-----------------------|------------------|-----------------------|-----------|
| East Asia             | 118.7            | 3.2                   | 14.0      |
| Central Asia          | -                | -                     | -         |
| South East Asia       | 51.1             | 2.3                   | 6.23      |
| South & Southwest Asia| 649.5            | 5.2                   | 79.27     |
| Asia                  | 819.3            | 1.45                  | 100.0     |

There is paucity of documentation on the extent of the economic contributions of draft buffaloes in Asian economy but the magnitude of such contributions is hidden in the value and volume of production of major agricultural crops such as rice, corn, sugar cane, coconut and others. Utility of swamp buffaloes for draft is reported as high as 65% of the 2.3M population in Myanmar (Hlaing, 2001) and about 66% of the population in the Philippines. Attempts to estimate the value of draft buffalo given the production value of rice, corn, coconut and sugarcane, major crops on which draft animals are used in the Philippines is shown in Table 7.

The fact that the massive farm mechanization resulted in significant reduction in the population of swamp buffaloes demonstrates the direct relationship between draft animal and small-hold farming in Asia. In Thailand, where 20-30% draft requirement is supplied
by buffalo (Na-Chiangmai, 2001), there was a drop of about 26.69% in buffalo population in 1996, the time when government program on farm mechanization was at its peak. The continued reduction in population of swamp buffalo in Malaysia is also directly related to the usage of tractors in large palm oil plantations and in the intensively managed rice-producing areas (Ariff Omar, 2001).

Buffalo Hide Production

Buffalo hide production is a function of population and the extraction rate from the said population. In South and South West Asia where buffalo population is about 77.3% of the region, the fresh hide production is about 79.27%. Majority of these hides are produced in India, (64.0%) and Pakistan, (10.46%). To further enhance growth in the leather industry in India, the Central Leather Research Institute (CLRI) has given emphasis on developing the technology to suit the requirements of upholstery leather using eco-benign chemicals and eco-friendly processing options (Gupta et al., 2005) in processing buffalo-derived hides.

Existing Breeds of Asian buffaloes

To date, there are still many recognized distinct breeds/strains of both riverine and swamp buffaloes in Asia; some are more common while many are less known and are destined to get lost in the future in the absence of organized and deliberate efforts to save these breeds. India has about 22 breeds of the riverine type (Ahlawat et al., 2006) (Table 7), most popular of which are the Murrah and Nili-Ravi, noted for their high milk yield performance. Zaffarabadi is popular in many countries for crossbreeding due to its inherent big size, harnessing its meat-producing potentials as well. In Pakistan, 34% of the buffalo population is Nili Ravi, 21% Kundi and the rest are nondescript (Khan, 2001).

Swamp buffaloes are distinctly of Chinese origin and has 18 known breeds/strains in China (Yang & Zhang, 2006) while Indonesia has identified seven breeds/strains (Triwulanninghsi et al., 2006). Among the breeds of Indonesia, the spotted swamp buffalo is more unique and largely raised for socio-religious purposes. Animals used for special rites command very high prices. The swamp buffalo found in the Philippines are believed to have originated from China although some deliberate efforts were made to import Chinese

---

Table 9. Breeds of Buffaloes in India

| Breed      | Milk Yield by kg/Lactation |
|------------|--------------------------|
| 1. Bhadawari | 1,150                    |
| 2. Zaffaradabi | 2,200                    |
| 3. Marathwada  | 960                      |
| 4. Mehsana    | 2,000                    |
| 5. Murrah     | 2,000                    |
| 6. Nagpuri    | 900                      |
| 7. Nili-Ravi  | 1,800                    |
| 8. Pandharpuri| 1,502                    |
| 9. Surti      | 1,300                    |
| 10. Toda      | 750                      |
| 11. Godavari  | -                        |
| 12. Sikamese  | -                        |
| 13. South Kanara | -                      |
| 14. Takai     | 1,054                    |
| 15. Manda     | 450                      |
| 16. Paralakhemudi | 1,200                  |
| 17. Sambalpuri| 2,220                    |
| 18. Chilika   | -                        |
| 19. Jerangi   | -                        |
| 20. Kalahandi/Peddakimidi | -                |
| 21. Kujang    | 915                      |
| 22. Banni     | 2,000                    |

Source: Ahlawat et. al. 2006
Shanghai buffaloes in the early part of the century. Thai swamp buffaloes are found mostly in the northeast of Thailand and have received special program of selection and improvement for growth and size. Selected breeders have 900 to 1000 kg live weight. Interestingly, there are also herds of swamp buffaloes in India, mostly in the Brahmaputra area, with average mature live weight of 340 kg.

III. Current & Emerging Trends in Buffalo Production in Asia

Buffalo and Smallhold farmers in Cooperativism and Enterprise Development

There is no denying that livestock has been a part of human history, not only as an important source of food, but also for tillage and transport. While other species of farm animals have been widely commercialized from its traditionally wild and natural habitat in the early centuries, buffalo can be considered a late entrant, commercial-size operation becomes more pronounced only when domesticated breeds have been introduced outside of Asia. The traditional role of buffalo as source for draft and transport still remains dominant in most of East and Southeast Asia, and is usually associated with the small-holder farmers in mixed-farming system.

Even in South Asia, where most of the riverine-type buffaloes are believed to have originated, and where buffalo usage is more than for draft, dairy buffaloes still belong to the small-holder producers, tending 1-5 head of buffaloes per household. Commercial-size buffalo dairy farms in peri-urban areas are of very recent developments. Yet, these peri-urban dairying depend largely on the small-breeder producers for sourcing their stocks. The social dimension of buffalo in small-holder farmers in Asia may be better appreciated when the extent of rural poverty in developing country regions is taken into account. The share of rural population as percentage of the total was 81 to 83% in various East, South and Southeast Asian regions and has a registered number of rural poor of 652 million, much larger than the combined number of rural poor in Latin America and the Caribbean, West Asia and North Afri-

Table 10. Fresh Buffalo Hide Production in Asia 2003

| CHINA          | INDONESIA          |
|---------------|--------------------|
| 1. Binhu      | 10. Cruizhou       | 1. Aceh Buffaloes |
| 2. Dechang    | 11. Haizi          | 2. Java Buffaloes |
| 3. Dehong     | 12. Jianghan       | 3. Binanga Buffaloes |
| 4. Diandongnan| 13. Shanghai       | 4. Moa Buffaloes |
| 5. Dongliu    | 14. Wenzhou        | 5. Spotted Buffaloes of South Sulawesi |
| 6. Enshi      | 15. Xilin          | 6. Kalang Buffaloes |
| 7. Fuan       | 16. Xinglong       | 7. Pampangas Buffaloes |
| 8. Fuling     | 17. Xinyang        |                   |
| 9. Fuzhong    | 18. Xanjin         |                   |

Source: Yang & Zhang, 2006                                               Source: Triwulanninghi et al., 2006
ca and Sub-Saharan Africa of 364 million in 1994-1995 data (Gryssels et al., 1997). Recent data on poverty as an object of the Millennium Development Goals of the United Nations pointed out reduction in incidence of poverty, but the pattern of occurrence is still the same. In 2002, Thornston et al. mapped out poverty and livestock in developing countries and indicated that high densities of poverty-stricken livestock-keepers appear mainly in mixed irrigated and mixed rain-fed systems in Asia. The importance of livestock-keeping among poor and landless is shown by their greater derivation of income from livestock sources than do the relatively better-off in the rural community (Delgado et al., 1999).

World Bank (2001) described that the rich perceive poverty as deprivation of materials for well-being; the poor, on the other hand, perceive poverty as a more multi-dimensional social phenomenon: it ranges from food and material deprivation to the psychological experience of multiple deprivations. The poor’s dimension of poverty underscores the importance to them of livestock. Dorward and Anderson (2002) have cited the importance of relating asset function and livelihood strategies. Applied to livestock, three livelihood strategies are suggested: “hanging in”, where livestock play buffering and insurance roles; “stepping up”, where livestock go beyond subsistence and contribute to building up of other assets; and “stepping out”, where productivity in livestock is less important than their holding value as savings.

Buffalo-keeping by smallholder producers contributes significantly to on-farm diversification and intensification, which is an important strategy to generate additional income.

“Businessizing” the small-holder producers

In South Asia, small-holder producers have demonstrated success in buffalo dairying by putting huge investment in vertical integration, e.g., linking farm production to agro-processing, value-adding and marketing. Availability of tools for feed conservation, product processing and infrastructure improvement are all factors that can support buffalo-keeping poor.

“White Revolution” in India captured the potentials of the small-holders as the production base and organized them into a three-tiered structure to handle the post-production concerns. Initiated in 1971, average milk procurement increased from 2.56 million kg/day in Phase I to 11.0 million kg/day in Phase III. Today, the dairy cooperative network is comprised of about 11 million farmer members, over 100,000 village Dairy Societies, 180 District Milk Producers and 18 State Level Dairy Federations. The powerful impact of “White Revolution” is being seen in the effect it has on small and marginal farmers with low input, low output activity with about ¾ of rural household owning 2-3 milk animals (Vyas, 2004). In this phenomenal transformation, buffalo is favored by farmers mainly because it is not alien to their marginal way of life, and secondly, due to high milk fat which is directly proportional to the price of milk.

The highly organized Cooperatives has been revamping product portfolio to make it formidable in Indian food business. It has launched various dairy products from ice cream, cheeses and infant products, among others. It has also created distribution network for all 4 types of supply chains, e.g., fresh products, frozen products, refrigerated products and ambient products, servicing about 500,000 retail shops across the country. As clearly articulated by Vyas (2004), the India White Revolution is a manifestation of the larger truth that any form of economic and political activity that does not carry the aspirations of the silent and deprived marginal and small farmers is entitled at best to a short-lived success.

The evolving model for small-holder dairy development in Asia takes the learnings from the Indian successful small-holders business entrepreneurship.
Organized Crossbreeding of Swamp and Riverine Buffaloes – from Draft to Milk and Meat

China, most of Southeast Asia and Sri Lanka are common on the traditional use of water buffaloes – mainly for draft in rice-producing areas. The expansion of irrigation and intensification of agriculture in these areas have resulted in increased usage of farm tractors substituting significant number of working buffaloes. This relationship is clearly demonstrated in Table 4, indicating that in countries where annual growth in tractor usage is high, the buffalo population had negative growth rate. These are developments that have directly affected the utilization of water buffaloes in this region. The easy and practical move of farmers who found no more interest to raise buffaloes is to dispose their animals, majority of which end up in slaughterhouses, resulting in negative growth in buffalo population.

In countries such as the Philippines and China where water buffaloes are generally swamp type and mainly used for work, government efforts to transform the huge population of swamp buffalo from being work animals to efficient milk producers were initiated by crossbreeding the riverine animals with the local breed. The direction in the Philippines is a continuing backcrossing with the Murrah breed with the aim of producing close to purebred dairy animals on the third or fourth generation. Chinese program, on the other hand, focuses on creating three breed crosses involving Murrah and Nili Ravi and the local swamp breed.

Murrah was introduced in China as early as 1957 from India and Nili Ravi from Pakistan in 1974. To date, there are about 200,000 crossbred buffaloes in China (Yang & Zhang, 2006) composed of crosses of M x Swamp or NR x Swamp and population of triple crosses involving M x N x Local Animals – all for milk production and their multiplication is aggressively promoted by the Chinese government as part of a grand program of dairy development. Production performance of the various crossbred buffaloes in China shown in Table 11 is at a level comparable level to that of the purebred animals.

Organized crossbreeding of the Philippine Carabao with the Murrah breed was initiated in 1984 with the establishment of semen processing laboratory which allowed availability of reasonably priced frozen buffalo semen for large-scale crossbreeding program. To date, the AI system can deliver 55,000 insemination services per year, representing about 5% coverage of breedable female carabaos.

| Breed                  | N  | Lactation Length | Milk Yield  |
|------------------------|----|-----------------|-------------|
| Swamp (S)              | 70 | 280.4 ± 202     | 1092.80 ± 207.40 |
| Murrah (M)             | 237| 324.7 ± 73.9    | 2132.90 ± 078.30 |
| Nili Ravi (NR)         | 164| 316.8 ± 83.6    | 2262.20 ± 663.90 |
| S x M F1              | 157| 313.7 ± 96.7    | 1240.50 ± 479.80 |
| S x M F2              | 118| 313.9 ± 90.1    | 1423.00 ± 534.50 |
| S x NR F1             | 45 | 326.7 ± 96.4    | 2041.00 ± 540.90 |
| S x NR F2             | 57 | 321.4 ± 01.8    | 2325.00 ± 994.41 |
| S x M x NR            | 168| 317.6 ± 78.4    | 2294.10 ± 772.10 |

Source: Yang et al.2003
Expansion of AI services towards privatization started in 2006 with the training of additional 2000 private village-based AI technician (VBAIT) over a period of 3 years with the intent of covering about 50-60% of the breedable female carabaos throughout the country. This activity is carried out in concert with the organized selection and progeny testing of riverine bulls out of the institutional herds and selected farmer-cooperative animals. F1 crossbreds have growth performance record about 75% more than the local breeds and have an average milk production of 4.5 kg as against the 1.25 kg of the local animals. There is linear increase in milk production with increasing blood of riverine among backcrosses.

Harnessing the Buffalo for Quality Meat Production: the “Pink Revolution”

The recognized importance of water draft buffaloes in most of East and Southeast Asia is reflected in some government regulations of imposing “slaughter ban” to allow the growth in population of work animals. In the Philippines, such slaughter ban was in effect as early as the 1960s and was only lifted in 1998. Indonesia shares the same outlook and up until the present there is a ban on slaughter of female buffaloes. The lifting of the slaughter ban in the Philippines was in response to the result of an in-depth study indicating that such a measure is counterproductive in many aspects.

When buffaloes are used for work and then sent to the slaughterhouse at retirement age, the meat derived is definitely tough and of inferior quality. This has created negative impression among the general consuming public and painted an image of what buffalo meat is. However, comparison of meat from young buffalo and young cattle has clearly shown that buffalo meat is indeed as good as cattle meat (Heintz, 2001). But results of feeding trials comparing buffalo and cattle of similar age, feeding regime and carcass treatment clearly demonstrated that there is enough scientific evidence to show that buffalo meat is more tender than beef (Neath et al, 2007).

In fact, swamp buffaloes in Australia have been utilized to produce “tenderbuff”, and this product represents good quality meat with high acceptability ratings in Australian market, initiated between 1987 to 1990 (Lemcke, 2004). Riverine bloodlines have been introduced in 1994-97 and this has radically altered the productivity of “tenderbuff”, with increments of 40% in growth rate above the swamp buffaloes.

One single important recent development related to buffalo meat has occurred in India. In spite of its big potential for meat production owing to its huge livestock population, the Indian meat industry did not grow in the early years due to socio-religious concerns. The reported compounded average growth rate during the last two decades was only about 4.6% as against 21.0% during the last few years (Ranjhan, 2004). This growth was fuelled by the increase in buffalo meat exports of about 159,703 MT in 1995-96 to as much as 459,937 MT in 2005-2006 (APEDA, 2007) Table 12, representing average annual growth rate of 18.7% in 1996-2006. Malaysia and the Philippines got about 33.6% of the total buffalo export in 2004-2005, the rest went to 10 other countries in the Middle East. In the Philippines, practically all brands of processed corned beef are derived from imported Indian buffalo meat constituting more than 50.0% of the total buffalo supply in the Philippines. This has allowed significant growth in the local meat processing industry in the country.

Intensive feeding of male buffaloes in commercial feedlot for quality meat production started in 1999. Male calves at the age of 8-10 months are purchased from farmers and fed high protein/high energy diet to put on additional weight of 120 kgs in 4 months. Murrah year-
ling grows by 0.9 to 1.0 kg/day and would have high dressing percentage (Ranjhan, 2004). In a village demonstration farm, the project house 5,000 male calves. This has created so much interest and awareness among farmers to the extent that the traditional high mortality rate of male calves of about 80% has been reduced to only 7-8% after the initiation of the project. Assuming that India has the capacity to produce 30M calves yearly, of which 15M are males with 90% survival rate till weaning age, rearing those to produce 150 kg carcass each will be equivalent to 2.025 million kg., raising the current India’s buffalo meat output by 340%.

Attendant to the remarkable growth in meat production in India in recent years is the establishment of modern slaughterhouses and meat processing facilities that meet international standards, enabling the growth in meat exports. This is India’s “Pink Revolution” and is certain to increase income of millions of small-hold buffalo producers.

### Table 12. Export of Buffalo Meat from India (1995-2006)

| Year       | Volume MT   |
|------------|-------------|
| 1995-96    | 159,703.91  |
| 1996-97    | 157,574.00  |
| 1997-98    | 176,328.68  |
| 1998-99    | 153,956.15  |
| 1999-00    | 167,291.41  |
| 2000-01    | 288,027.84  |
| 2001-02    | 243,355.58  |
| 2002-03    | 297,897.26  |
| 2003-04    | 343,817.08  |
| 2004-05    | 337,777.65  |
| 2005-06    | 459,937.63  |

Source: Ahlawat et. al. 2006

### Intensification of R&D on Water Buffaloes

Interest on intensification of R & D in water buffalo in Asia is seen in greater magnitude as Indian where support to establishment of institutions and manpower capacitation started at an earlier years. Organized efforts in other Asian countries are of later developments. In India, following the positive results of the All-Indian Coordinated Research Project (AICRP) on buffalo breeding launched in 1970, institutionalization of buffalo research and development was undertaken through the establishment of the Central Institute for Research in Buffaloes (CIPRB) in Hisar in 1985. The Institute coordinates the All-Indian Network Project on Buffalo Improvement focused on various breeds in different specific regions of the country (Dhanda, 2006). In 1993, an inter-agency Network Project on Buffalo Improvement was initiated to increase intensity of selection of bulls from large population and increase the number of progeny-tested bulls. Research on water buffalo were also initiated in earlier years in China, but the more significant aspect began in 1995 when the Buffalo Research Institute with the Chinese Academy of Agricultural Sciences and Buffalo Stud Bull Station in Guangxi, were re-established.

In the Philippines, following the 10-Year UNDP-FAO project on Strengthening the Carabao Research and Development (1982-1992), the government institutionalized the Philippine Carabao Center (PCC). It is a dedicated government institution in charge of R&D and promotion of buffalo as sources of milk, meat and draft, and has a network of 13 Centers throughout the country created by Republic Act 7307 and became operational in 1993 (Cruz, 2006). Since then, PCC became the hub of intense buffalo R&D and has linked with various national institutions. Technical cooperation on buffalo production improvement was undertaken with the Japanese Government, through the Japan International Cooperation
Agency (JICA), and with various Japanese universities. Likewise, collaboration between the Australian Government through ACIAR on buffalo genetic improvement project was carried out. Lately, PCC has closely collaborated with the National Livestock Research Institute and KOIKA of the Korean Government.

**Genetic Conservation Initiatives**

Deliberate crossbreeding efforts, as in the case of China and the Philippines, or the indiscriminate crossbreeding in other major buffalo-producing countries, are threats to the long-term stability of indigenous breeds, if there are no programs to save these existing genetic resources. Interest is now becoming intense on averting the genetic loss due to the current practice of sending high-yielding dairy buffaloes raised in peri-urban dairy farms to slaughterhouses.

In the Philippines, the program has established a distinct gene pool for the Philippine swamp Carabao, apart from the gene pool of riverine buffaloes. This measure ensures that the outstanding indigenous animals are selected to form part of a continuing improvement program within the local animal breed. Along this line, there is also a gene bank where frozen semen, embryos and cells of outstanding animals are kept for future breeding usage. Likewise, the government has supported the Tamaraw Conservation Program (TCP) aimed at protecting the Tamaraw (*Tamaraw mindorensis*), a specie within the buffalo family, from being extinct.

One of the outstanding programs on swamp buffalo conservation and improvement has been installed in Thailand since several years back. Selected animals are reared in the Surin Buffalo Research Station and outstanding sires are used to improve the indigenous swamp buffalo population. The animals are selected for growth and related characteristics.

Another interesting program to conserve and utilize indigenous breed of swamp buffalo is being carried out in the regions of Chaoshan Plain in Guandong province of China. Scientists are selecting from among the local buffalo population high milk-producing animals to develop a dairy-type swamp buffalo (Zhang *et al.*., 2006). On the other hand, the Haralieh Animal Propagation Station (HAPS) of the Livestock Research Institute (ILRI) in Taiwan concentrates its work on genetic Conservation of swamp buffaloes (Faa and Duh, 2006). In India, the National Bureau of Animal Genetic Resources (NBAGR) is actively looking into buffalo genetic resources conservation. Today, Bhadawari and Surti are considered breeds facing significant reduction in number.

**Concluding Statement**

The Asian buffalo will still be a small-holder animal in the foreseeable future, playing an important role in the lives of resource-poor farming families in the developing countries in Asia. Harnessing the full potential of this Asian animal will benefit the majority of the rural farming families and at the same time meet the requirements of the fast-growing Asian economy.

In recent years, the swamp buffaloes in the intensively irrigated areas of Southeast Asia as source of draft power are being replaced slowly by farm machineries. In order that the existing huge animal resource can be of benefit to the rural farming families, transformation of these animals to become efficient producers of milk and meat by way of crossbreeding with riverine breeds is now being pursued with good degree of success.

The emerging interest in India to harness the enormous population of male buffalo calves...
as potential sources of good quality meat by way of introducing improved management technologies to dramatically reduce calf mortalities and increase average daily gain in weight will surely reap enormous benefits for millions of small-holder buffalo producers while meeting the growing demand for ruminant-derived meat products.

Lastly, the growing interest in intensifying research and development and international collaboration in Asia on water buffalo production improvement will undoubtedly result in enhancing the development of this species to further benefit the world.

REFERENCES - Abas Mazni O., A.R. Mohd. Padzil, A. Punimin, H.N. Quaza, Nizamuddin. 2006. Current Status and Challenges in Buffalo Production in Malaysia. Proc. Int. Seminar on Artificial Reproductive Biotechnologies for Buffaloes, Bogor, Indonesia, pp. 120-144. Ahlawat, S.P.S., D.K. Sadana and P. Pandey. 2006. Buffalo Genetic Resources and their Conservation in India. Asian Buffalo magazine, Vol. 3:1, pp18-29. Allen, Jack, 2001. Water Buffalo Research & Development in Australia. Proc. Regional Workshop on Water Buffalo Development, Surin, Thailand, pp. 42-49. Ariff Omar, M. 2001. Buffalo for Meat Production in Malaysia. Proc. Regional Consultation on Buffalo Development, Surin, Thailand, pp.60-65. Chunxi, Zhang. 2006. The Model of Chinese Buffalo Breeding. Proc. 5th ABA Congress, Nanning, China, pp 166-185. Cruz, L.C. 2001. Water Buffalo Production System in Asia. Proc. Vth World Buffalo Congress, Macaraibo, Venezuela, pp 1-24. Cruz, L.C. 2006. Buffalo Development in the Philippines. Current Situations and Future Trends. Proc. 5th ABA Congress Nanning, China, April 18-22, 2006, pp. 28-36. Cruz, L.C. 2006. Ovarian Follicular Dynamics in Water Buffaloes (Bubalus bubalis) and its exploitation towards better ovarian responses. Proc. Int. Seminar on Artificial Reproductive Biotechnologies for buffaloes, Bogor, Indonesia, pp 1-17. Dhanda, O.P. 2006. Buffalo Production Scenario in India, Opportunities and Challenges. Proc. Int. Seminar on Artificial Reproductive Biotechnologies, Bogor, Indonesia, pp 159-167. Dhanda, O.P. 2006. Development of Indian Buffalo as Dairy Animal. Proc. 5th ABA Congress, Nanning, China, pp.112-119. Dorward, A.R and Anderson, S. 2002. Understanding small stock as livelihood assets: Indicators for facilitating technology development and dissemination. Report on review and planning workshop, 12-14 August 2002, pp. 4-7, Imperial College, Wye, UK. Dung, Chung Anh. 2006. Buffalo in Vietnam: Status and some Applied Reproductive Biotechnologies. Proc. Int. Reproductive Biotechnologies, Bogor, Indonesia, pp151-158. Eberstadt, N. 2007, Power and Population in Asia. Hoover Institution Policy Review. Faa, Shiao, Tzong and M.S. Duh. 2006. Recent advances in embryo transfer of swamp buffalo in Taiwan. Proc. Int. Seminar on Reproductive Biotechnologies for Buffalo, Bogor, Indonesia, pp. 14-1450 . Gupta, S, E. Raja B and Chandra Babu NK. 2005. Asian Buffalo Magazine. 2:1. pp. 32-37. Hlaing, S. 2001. Country report for workshop on water buffalo development-Myanmar. Proc. Regional Workshop in Water Buffalo Development, Surin, Thailand, pp.65-69. Kitalyi, Aichi, Louis Mtenga, John Morton, Anni MacLeod, Philip Thornton, Andrew Dorward, and M. Saadulah. 2006. Why keep livestock if you are poor? In livestock and wealth creation Eds E. Owen, A. Kitalyi, N. Jayasuiraja and T. Smith. Pp. 13-27. Heinz, Gunther, 2001. Water buffaloes as meat animals. Proc. Regional Workshop in Water Buffalo Development, Surin, Thailand, pp. 10-17. Khan, M. Sajjad. 2001. Water Buffaloes for food security and sustainable rural development in Pakistan. Proc. Regional Workshop on Water Buffalo Development, Surin, Thailand, pp.77-83. Lemcke, Barry, 2004. Production of Specialized Quality Meat Pro-
ducts from Water Buffaloes: Tenderbuff. Proc. 7th World Buffalo Congress, Manila, Philippines, Vol. I, pp. 49-54. Neath, K.E. A.N. Del Barrio, R.M. Lapitan, J.R. Herrera, L.C. Cruz, T. Fujihara, S. Muroya, K. Chikun, M. Hirabayashi and Y. Kanai. 2007. Difference in tenderness and pH decline between water buffalo and beef during post mortem aging. Meat Science 75, pp 499-505. Ranjhan, S. K. 2004. Commercial Production of Buffalo Meat with Social Agenda. Proc. 7th World Buffalo Congress, Manila, Philippines, Vol. I, pp. 1-7. Ranjhan, S.K. and S. Quereshi. 2006. Buffalo Development in Asian: Current Situation and Future Trends. Proc. 5th ABA Congress, Nanning, China, pp. 131-139. Sethi, R.K. and P. Sikka. 2006. Genetic Improvement of Indian Buffaloes. Proc. 5th ABA Congress, Nanning, China, pp 120-130. Sikap/STRIVE Foundation 2004. The Carabao Industry: Prospects and Strategic Directions. Tean, Bun. 2006. Situation of Buffalo Raising in Small-holder farms in Cambodia, Proc. Int. Seminar on Artificial Reproductive Biotechnologies for Buffaloes, Bogor, Indonesia, pp 79-82. Triwulanningsih, E. and L. Praharani. 2006 Buffaloes in Indonesia. Proc. Int. Seminar on Artificial Reproductive Biotechnologies in Buffaloes, Bogor, Indonesia, pp. 114-120. Vyas, B. M. 2004. White Revolution: A Remarkable Success in Dairy Development. Asia Buffalo Magazine, 2:1, pp. 4-9. Wei, Ling Yung, and Y.S. Lea. 2006. Conservation of water buffaloes in Taiwan Cryopreservation of spermatozoa. Proc. International Seminar on Reproductive Biotechnologies for Buffaloes, Bogor, Indonesia, pp. 108-113. World Population – Wikipedia, 2007 (http://en.wikipedia.org). Yang, Bingzhuang and Chunyi Zhang 2006. Buffalo Crossbreeding in China. Asian Buffalo Magazine, Vol 3:1, pp 4-10. Yaun, Zhang, Zhang Yi and Wang Yachun. 2006. Breeding Strategy for Dairy Buffalo in China – Converting from working type to dairy type. Proc. 5th ABA Congress, Nanning, China, pp 162-165. Zhang, Chuaxi, Baiyan Yang, Jing Qin and Ying Zhuge. 2006. Development of Dairy Buffalo Industry in China. Asian Buffalo Magazine, Vol 3:1, pp12-17.