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Full length Research

Nutrient Balance on Crop-Livestock Mixed Operations in Urban and Peri-Urban Agriculture of Kabul, Afghanistan

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Managing the environmental risk associated with mixed farming operation in the urban and peri urban areas of Kabul at present is a significant challenge. Despite the increasing demand for crop and animal production in the world, the excess build up of nitrogen (N), phosphorus (P), potassium (K) and organic carbon (C_{org}) in the soil of inhabited areas commonly considered as a source of ground and surface water contamination. Livestock feed and using nutrient rich inter-city wastes with subsequent reduced products, mostly add into this build-up of N, P, K and C in the soil. The degree of differences between input inflow and outflow in the farm defines the magnitude of potential environmental contamination. To monitor nutrient inflow and outflow, this study was conducted in urban peri-urban areas of Kabul for six months from Apr-Oct 2008. The nutrients N, P, K and C balance was constructed for four crop-livestock operated households to estimate the whole-farm surpluses of nutrient and to investigate the possibility for reducing upsurge. Our study showed Input/output ratio of 1.2:1, 4.1:1, 1.9:1 and 3.2:1 for N; 0.8:1, 1.9:1, 0.8:1 and 1.8:1 for P; 4.4:1, 6.6:1, 9.4:1, and 20.4:1 for K, and 3,312.0:1, 117.8:1, 361.4:1, and 312.0:1 for C in the household one (HH-1), household two (HH-2), household three (HH-3) and household four (HH-4), respectively. It has been found that, nutrient inputs (N, P, K and C) via feedstuff and crop inputs on crop-livestock mixed operation were greater than nutrient in the products. Management options that contribute to a more favorable nutrient balance were also identified. For safe and sound crop-livestock mixed farming. Strategies must be implemented, that address the commonly experienced balances of nutrient.

Keywords: Nutrient balance; Crop-livestock mixed farming, Kabul City, Afghanistan

INTRODUCTION

Agriculture in Afghanistan is the mainstay of economy accounting for 53 % of GDP and supports over 80 % of the population. Particularly livestock plays a major store of value and a main buffer in times of food shortages (FAO/WFP, 2004; CRS, 2001). According to the FAO, 2003 livestock census total number of animals comprised 3.7 million cattle, 8.8 million sheep, 7.3 million goat and 180,000 camels in the whole country with differences in number of cows per household 1.8 in the eastern region to 0.2 in the northern region (Bonnier, 2007). However, in Kabul Province, livestock and poultry is owned 55 % by Kuchi (nomads), 47 % rural farmers, whilst, urban farmers in great Kabul keep only 4 %. Traditionally in Afghanistan crop and livestock have been operationally separated but functionally linked, and had important role in the economy of household as livestock had 7 % share in GDP and 15 % of exports in 1976, as documented by IIT, (2010) providing milk, meat, manure for maintaining the soil fertility and dung for generation of heat for cooking.

A basic function of crop and animal productions is to transform nutrients into human food. Owing to, relatively inexpensive mode of feed and fertilizer many urban farmers mostly in the developed and somewhat in developing countries, use in excess of livestock and crop production requirements. Which cause extreme differences between inflow and outflow? However, differences in the farm provide a general indicator of farm risks to nutrient buildup, loss and environmental contamination (Powell et al., 2008; Saleem, 1998; Koelsch and Lesoing, 1999). Even so, the most meaningful account for an assessment of the nutrient environmental impact of farm operation is the nutrient balance of the whole farm (Sveinsson et al., 1998). Calculation of fluxes and balance of nutrients in a crop-livestock mixed production system provide some basic information for the assessment of its long-term sustainability and environmental safety. As it was stated urine contains the highest proportion of nutrients and faeces have a large amount of organic carbon and because of their hygienic significance, should always be treated (Krekeler, 2008). Though, whole farm nutrient balance generally does not address effect of nutrient management in one production component on the other (Powell et al., 2008) still, studies on nutrient balance at farm level (farm gate balance) have become a useful tool during the past decade as problem with surpluses and deficits of nutrient in agriculture have become relevant for the health of the biosphere. N, P, K and C are by far the most studied substances, probably because of the obvious environmental problems they create. Losses of N and P are critical to water quality issues associated with livestock manure (Koelsch and Lesoing, 1999). Previous study (Safi et al., 2010) in Kabul showed highly surpluses of N and P in different crop production farms. This may be a serious threat to future crop-livestock productivity and sustainability in urban and peri-urban agriculture (UPA) of Kabul. As well, common indicators have been found concentrations of nutrients such as nitrate and faecal bacteria in the ground water of Kabul (Houben et al., 2009).

Much is known about biological relationship between fodders fed to dairy cows, milk and manure produce under farm conditions as well as for crop production but less information is available on balanced nutrient inflows and outflows via feed and manure in crop-livestock mixed operations. For the purpose of this paper, only milk cows and their calves with corresponded fields in the farm were considered. The number of other animals was very small and their capacity to influence the nutrient balance was negligible. The intents of our study was to (i) define a whole farm nutrient balance on Kabul crop-livestock mixed operation in one growing season (Apr-Oct 2008) and (ii) identify characteristics to minimize the imbalance of nutrients and subsequently environmental infectivity in mixed crop-livestock operation in the study area.

MATERIALS AND METHODS.

Agro climatic structure of the study area

Afghanistan is a landlocked country located within South Asia and Central Asia. It has a population of approximately 32 million, making it the 42nd most populous country in the world. Kabul city is a city in Afghanistan. Kabul city located in a valley is one of the highest capitals in the world situated at an elevation of ca. 1,800 m. surrounded by the Lowgar and Paghman mountains in the south-east, Qrough mountain in the south-west, Shirdarwaza in the north east, Charikar in the north and the Tangi Gharow mountains in the west. Kabul city as shown in Figure 1 has a current population of 3.7 million (CSO, 2010-11) is located in a valley at about 1,800 m above sea level (a.s.l.) surrounded by high mountains (Figure 1). The average annual precipitation of 300-330 mm occurs mainly from November to May and the adjacent natural semi-desert steppe vegetation provides vast grazing grounds for small and large ruminants during three summer months. Average annual temperature varies between 10-13°C with a relative humidity of 54 % (1957-1977; Grieser et al., 2006; Houben and Tunnermeier, 2005). During the present study (April–October 2008) the climatic conditions were with an average annual rainfall of 176 mm, a relative humidity of 43.3 % and an annual average temperature of 15.3°C drier and hotter than normal (Safi et al., 2010). In the study area, rainfed wheat is grown on 6 % of the cultivated land and harvested between July and August, while irrigated wheat (*Triticum aestivum* L.), potato (*Solanum tuberosum* L.), fresh vegetables and forages occupying 94 % of the land are harvested between May and October. Irrigation systems are fed by diverted rivers and the traditional underground ‘Karez’ channel systems.

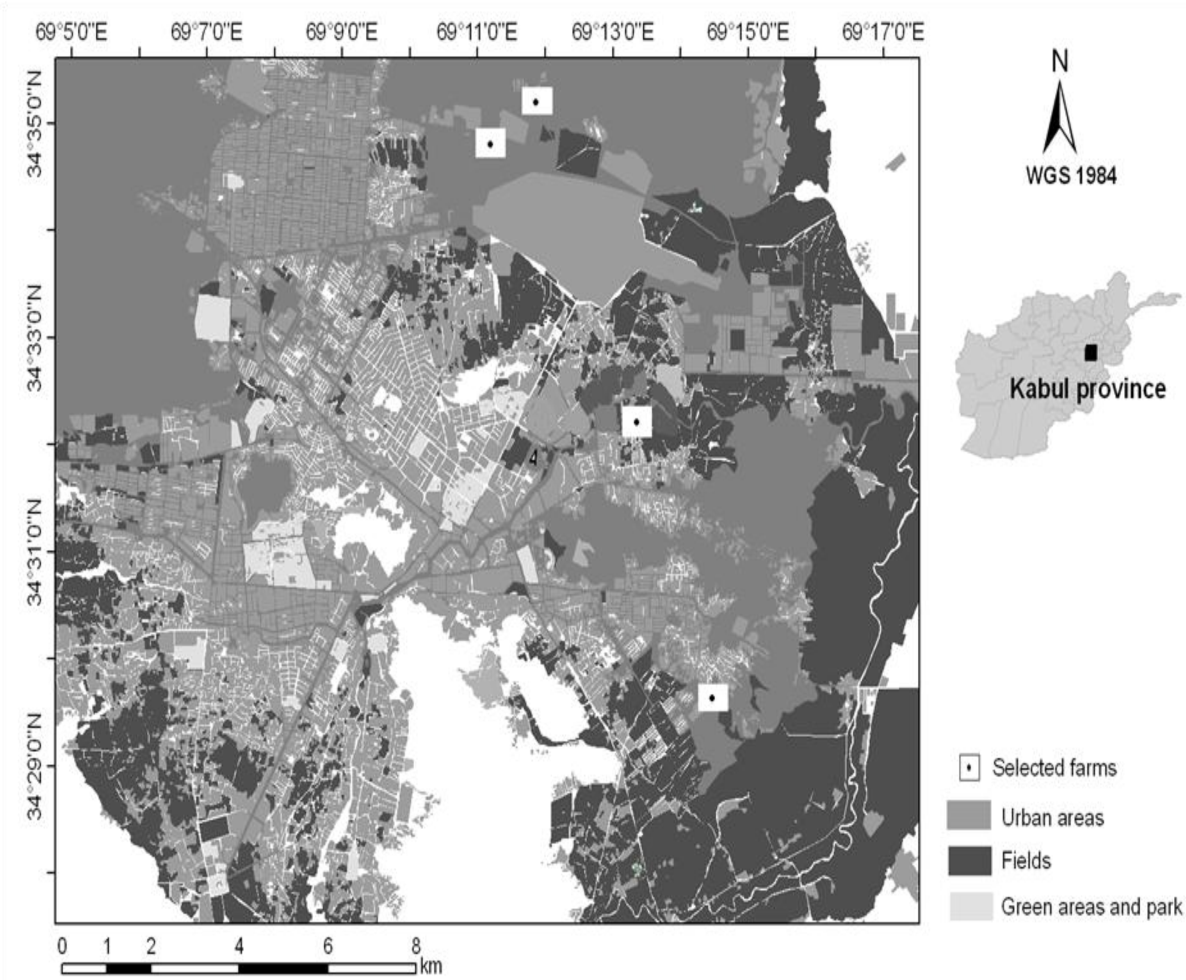

Figure 1: Map indicates location of four representatives' crop-livestock mixed operation HH in UPA of Kabul, Afghanistan.

Source: www.lib.utexas.edu

Farm selection

Average cultivated land of a farm household is 0.2 hectare (ha), but a few large households have irrigated farms of about 1 ha also. The livestock sector in the Kabul region is dominated by cattle (including dairy cows with four local breed of Wattani, Kandahari, Kunari and Sistani) and sheep, but also comprises goats, donkeys, horses and poultry. The influences of exotic breed (Friesian, Brwon Swiss, and Jersey) were also reported in the region by Bonnier. (2007).

For calculation of nutrient balance we have focused on four crop-livestock mixed operation with four owners participated in this study in Apr-Oct, 2008. The HH-1 was located in the central-East corner of the city, HH-2 in South-central corner, HH-3 and HH-4 in North-central corner with geographic location of 34°29' 59.76" N, 69°09'22.06" E; 1,765 m a.s.l.; 34°28'45.96"N, 69°12'54.94"E; 1,767 m a.s.l.; and 34°34'12.27"N,

69°14'13.15"E; 1,758 m a.s.l., respectively. The sampled sites were selected out of hundred by pre-structured questionnaire and were distributed along a 15 km transect crossing the city in a North-South direction, approximately from the *Beni-Hesar* to *Tarakhail village*. Subsequently farms were mapped with a handheld GPS. Crop-livestock inputs and outputs were recorded (Figure 2).

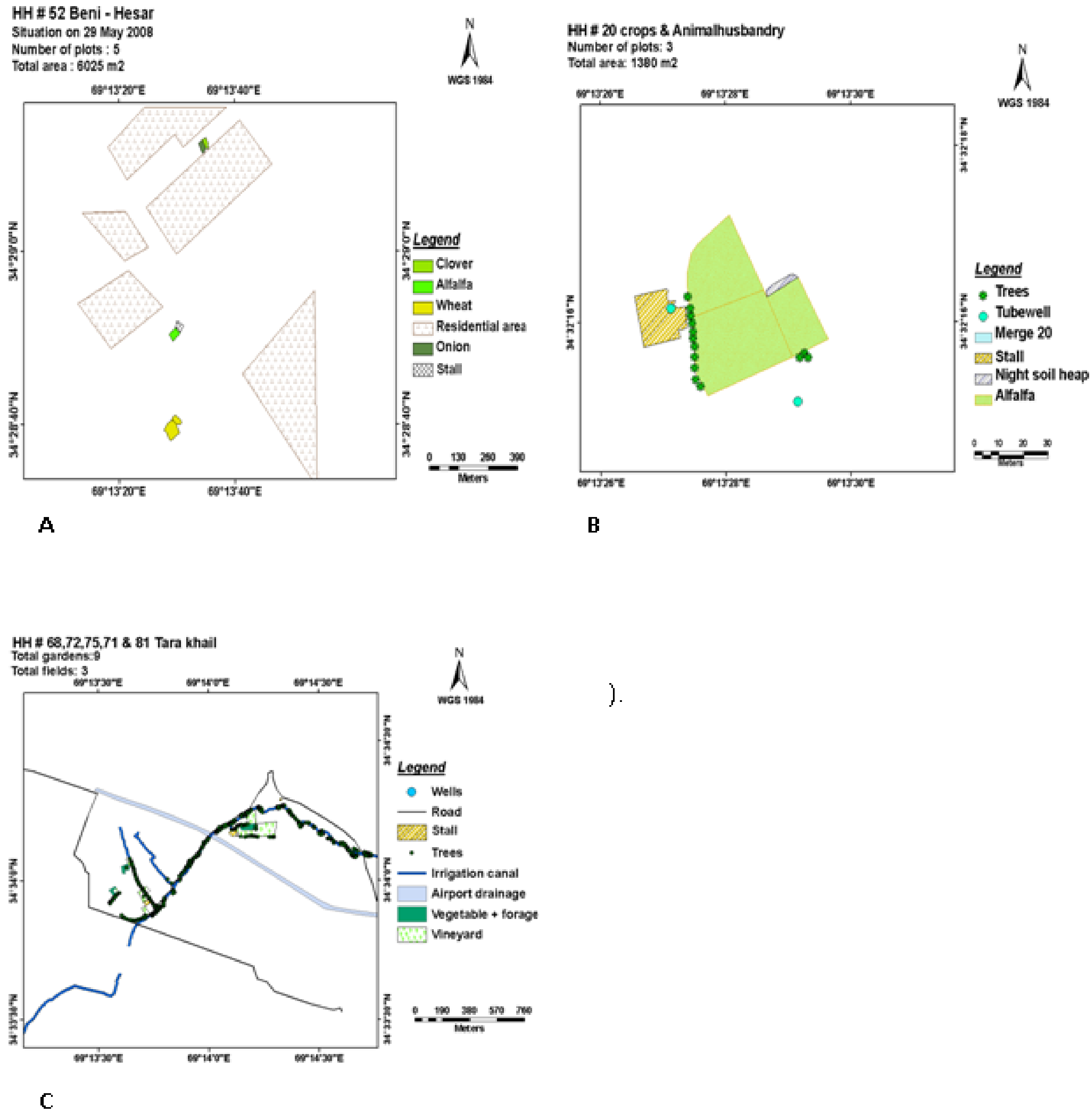

Figure 2: Maps are indicating farmers' drawn layout of setting of the stall, farmer's house and crop fields in HH-1(A), HH-2 (B), HH-3 and HH-4 (C and D, respectively).

Sampling

Irrigation water was sampled at each site three times per month during irrigation events. To avoid bio-chemical degradation after sampling and checking for pH, one drop of concentrated (32 %) HCl was added to each water sample before storage in polyethylene (PE) bottles at < 4°C until analysis of total N, P, K, and C.

During farmers' crop and fruit harvests, samples of about 300 g fresh weight of all removed (marketed) plant parts and residues of vegetables, cereals and grapes were taken from five points in the field, pooled, weighed, dried to constant weight at 60°C for 48 h, and weighed again for moisture content correction. Livestock feed samples (in the duration of 6 months) were collected individually from each farm dried and

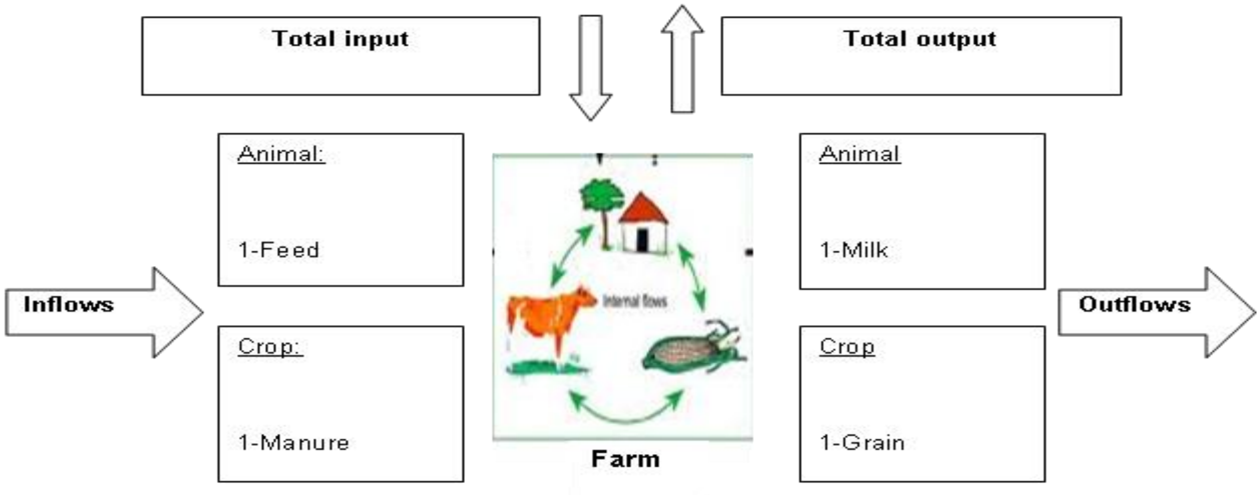

Figure 3: General model, representing nutrient inflow, outflow and recycling in the crop-livestock mixed operation in UPA of Kabul city, Afghanistan.

Were ground with a mill (T-Tecator Cyclotec 1093, Höganäs, Sweden) to a size of 0.5 mm, and stored in sealed PE bags until analysis of N, P, K, and C_{org}.

Samples of manure applied to the crop fields, and manure collected from livestock stalls (bedding and excreta) at each household, five sub-samples from the manure heap were taken with a 5 x 20 cm soil sampler to about 0.5 m depth, pooled, air-dried at room temperature for 48 h, and ground with a Retsch mill (Model MM 301, Retsch GmbH, Haan, Germany). These samples were stored in PE bottles until analysis for dry matter (DM), N, P, K and C_{org}. Milk production per household (marketed and self used) measured with a quantified container daily and summed up for the whole period of study. Live weight estimated for calves (0.753 kg day^{-1}) according to Pasha et al. (2009) while live weight gained/day calculated for adult cows (0.450 kg day^{-1}) according to straw technology developed by Bangladesh Livestock Research Institute (BLRI). National encyclopedia of Bangladesh, No date)

Chemical Analyses

The N, P, K and C_{org} concentrations of various inputs and outputs was analyzed individually for each farm as follows: In harvested crops and animal feeding stuffs total N was determined using a LECO FP-328 (Leco Corp., St. Joseph, MI, USA) and C_{org} according to the method described by Close and Menke. (1986). A conversion factor of 1.724 from C_{org} to organic matter (OM) was used based on the assumption that OM contains 58 % of organic C (Nelson and Sommers, 1996). Samples were dry-ashed at 550°C, dissolved in HCl and analyzed for P by spectrophotometry and K by flame photometry. In manure samples, adherent sand particles were removed according to Naumann and Bassler. (1988).

In irrigation water samples, dissolved organic carbon (DOC) and total N were analyzed using a Dimatec 100 automatic analyzer (Dimatec GmbH, Essen, Germany). The P and K were analyzed by spectrophotometry (Hitachi U-2000, Tokyo, Japan).

Total manure N and C were determined by a Vario MAX CN/CHN/CNS analyzer (Elementar Analysensysteme GmbH, Hanau, Germany).

Total C derived from photosynthesis was estimated by multiplying total DM harvested by factor 2 (assuming that root dry matter and net exudation were about equal to total above-ground DM).

Biological nitrogen fixation estimated by 30 to 60 % of the total nitrogen output in 1^{st} – to 2^{nd} year legumes crops, respectively (Koelsch and Lesoing, 1999).

The N, P and K in cattle live weight gained estimated by 2.80, 0.73 and 0.2 % of body weight (BW), respectively (Ternouth, 1990; Annenkov, 1982; and Cornell Nutrient Management Spear Program, 2008) while N, P and K concentration in milk was estimated according to Cerosaletti et al. (2004).

Balance Calculation:

An accounting of nutrient inputs (feedstuff, fertilizer, concentrate and supplements. Irrigation water, rain water and biologically fixed nitrogen) and managed nutrient outputs (livestock and crop outputs exported off the farm) was completed for cattle feedlots, table grape gardens and fields, procedures used by Koelsch and Lesoing. (1999) was used in constructing a nutrient balance (Figure 3). The nutrient balance is expressed as a ratio of nutrient inputs to outputs to provide a more direct measure of the relationship between inputs to outputs. The value is calculated as follows:

$$NIR = NI \,/\, NO \quad ....1$$

where NIR stand for nutrient imbalance ratio, NI denotes nutrient input and NO stands for nutrient outputs.

Statistical Analyses

Average of the all nutrient N, P, K and C applied for crop-livestock production calculated for each HH in hectare basis. Subsequently average of all nutrient N, P, K and C (via productions and others e.g. animal sold, died and … etc.) removed from the farm gate. Calculation of ratio between input/output was done by applying equation one. The nutrient N, P, K and C cast-off in the farm was not considered. Due to short duration measurement, the data were not fit to the use of statistical analyses for the mean and standard deviation.

RESULTS

General characteristic of farm entities

This study was carried out in different households (HH1-4) with subsistence and commercial crop-livestock mixed operation farming communities in the urban and peri-urban area (UPA) in Kabul city, Afghanistan during Apr-Oct 2008. The general characteristic and values of the different households (n=4) for the arable land, number of cattle, lactating cows, inputs feedstuffs, milk produced and manure obtained, are presented in Table 1.

The HH-1 was situated in the area of commercial vegetable production, had two lactating nondescript cows and two calves with an average milk production of 11.76 kg day^{-1}, while the HH-2 was located in the area of cereals and cash crop production, had two lactating cows and two calves with an average milk production of 2.75 kg day^{-1} this was somehow in consistent with the values of milk produced by Watani breed of 3.5 kg day^{-1} in Afghanistan reported by Bonnier. (2007). The HH-3 and HH-4 having one lactating cows with two calves and three lactating cows with four calves with an average milk production of 5.04 and 9.48 kg day^{-1} in the area of vineyards, respectively. The facilities were confine stall with zero grazing possibilities during cropping period in surrounding fields and gardens. As usual in all HH manure accumulated in dry lots. The organic portion of the manure (64 %) was used for making dung cake for heat generation; the rest materials (34 % urine and bedding) were used in the fields and gardens.

Crop land area in these mixed farms was different ranging from 0.1 to 1 ha. Reaching maximum in HH-3 with an area of 1 ha followed by HH-2 an area of 0.6 ha and HH-4 with an area of 0.5 ha while HH-1 had the minimum land base. Land tenure was also different; HH-1, HH-3, and HH-4 had own land while, HH-1 used leased land for forage production. Area used for livestock ranged from 0.004-0.007 ha/livestock reaching maximum in HH-4 followed by HH-1 and HH-3 with an area of 0.005 and 0.004 ha/livestock, respectively while HH-2 had the minimum land base for each livestock. In general all farms used limited area as a livestock stall. It will help to ease management of the wastes. Concentrating cattle would reduce manure surface area exposure to rainfall (Powell et al., 2008).

The HH-1, HH-2 and HH-3 produce some forage in their land but HH-4 by having vineyard gardens, most of the forages imported off the farm. Occasionally they grow few types of forages in between furrows of the vineyards and leaves of the grape were fed to livestock during the shortages of feedstuffs while feed concentrates and mineral/vitamin supplements were also the purchasing items in all HH. Even though, feeding of mineral was not observed during study but farmers mentioned feeding some in their interviews. For crop production inter-city wastes (sewage water, night soil from the local toilets) were used in substantial quantities. One of the unique characters of these households was using clean water for animal consumption. Diseases in the livestock of HH-1 and HH-4 were observed as a disturbing agent of the farm animals.

Table 1: General characteristics of crop-livestock mixed operation HH participating in the study (n=4)

Item	Average	SD	Minimum	Maximum
Number of cattles	4.5	1.7	3.0	7.0
Number of lactating cows	2.0	0.8	1.0	3.0
Inputs feed t/period	6.6	1.1	5.1	7.7
Total milk produced t/period	1.9	1.5	0.6	4.0
Total manure produced t/period	0.3	0.4	0.03	1.2
Arable land (ha)	0.5	0.3	0.1	1.0
Area of stall (ha/livestock unit)	0.005	0.0014	0.004	0.007

Milk production (per lactating period)
Manure 170 days
Fodder 170 days
Live weight 170 days

Table 2: Feedstuff (DM kg/herd) fed to livestock in four UPA crop-livestock mixed operation in UPA of Kabul.

Household	Wheat straw	Alfalfa	Dry bread	Cotton
HH-1	2,917[b]	1,765[a]	927[b]	1,070[b]
HH-2	3,072[a]	1,565[a]	947[b]	1,146[b]
HH-3	1,361[b]	3,973[a]	1,098[b]	1,308[b]
HH-4	2,746[b]	1,521[a]	325[b]	473[b]

[a]market
[b]own

Livestock feeding pattern at different HH under UPA

As it was revealed from the result of our extended face to face interaction with the farmers, dairy was an important source of income for our studied HH in the city. Fodders were the relatively rare substances in the region especially during the years of drought. According to the farmer's experience, to increase the palatability of the feedstuff wheat straw was mixed with alfalfa or corn. Furthermore, dried bread and cotton seed cake (CSC) was used to increase milk production and resistance against diseases whereas livestock were not allowed to graze in the area because of tight crop production and residential neighborhoods of the inhabitants, therefore, forages offered to livestock in the stalls was three times a day. Additionally, concentrates and supplements were used to buy from the city market. The proportion of offering feedstuff for whole period of measurement ranged from 18 – 54 % of wheat straw, 23 – 51 % of alfalfa, 6 – 14 % of dried bread and 9 – 17 % of cotton seed cake in all farms. As a whole livestock feed in HH-1, HH-2 and HH-4 was dominated by wheat straw (the cheapest feed) whereas HH-3 was the only HH with subjugated amount of alfalfa 51 % Table 2.

Nutrient imported into the farm via livestock feed vs. crop inputs

The results for total nutrient input of the N, P, K and C inflow into farm via feeding stuffs and crop inputs, are presented in Table 3 which indicates that in HH-1, HH-2, HH-3 and HH-4, total imported nutrient for crops and livestock were ranged 1.1 - 4.4 and 95.6 - 98.9 % of N; 0.2 -16.0 and 84.0 -99.8 % of P; 0.7 – 4.8 and 95.2 - 99.3 % of K and 2.0 – 4.6 and 95.4 – 98.0 % of C, respectively. It has been emphasized that, in spite of livestock feedstuff as a major source of nutrient N, P, K and C, traditional use of nutrient richer inter-city wastes for crop production in the farm was as well contributor to the amount of N, P, K and C in association with a third largest source of N fixed by biological nitrogen fixation in dairy farms. Though, regarding K, none of the farmers imported K as chemical fertilizer while, C

Table 3: Total nutrient N, P, K and C inflow into the farm via crop and livestock inputs feed

HH	Input	N ha^{-1}	P ha^{-1}	K ha^{-1}	C ha^{-1}
1	crop[a]	312	10	114	17,064
	livestock[b]	27,380	4,412	16,666	601,785
2	crop	254	74	168	13,919
	livestock	16,465	2,413	3,350	291,193
3	crop	485	192	310	6,585
	livestock	12,072	1,880	7,526	293,426
4	crop	501	285	234	7,647
	livestock	10,853	1,499	10,620	378,978

[a]Covered whole year application
[b]Covered six months period

Table 4: Mean, standard deviation (n = 4), minimum and maximum nutrient import-export onto and off the 4 UPA mixed farms of Kabul, Afghanistan.

Mean of	Item	Average	SD	Minimum	Maximum
Import via crop	N	388	124	254	501
	P	140	140	140	140
	K	206	206	206	206
	C	11,304	11,304	11,304	11,304
Import via livestock	N	16,692	7,521	10,853	27,380
	P	2,551	1,296	1,499	4,412
	K	9,540	5,607	3,350	16,666
	C	391,346	146,124	291,193	601,785
Export via crop	N	51	38	19	93
	P	6	6	2	13
	K	35	24	14	62
	C	1,448	972	618	2,518
Export via livestock	N	6,399	3,654	3,467	11,467
	P	1,922	917	1,005	2,722
	K	920	664	472	1,888
	C	102	78	31	212

Values in the table indicative of kg ha^{-1}

fixed by photosynthesis was observed the largest source for C imports into the farms.

Nutrient export of the farm via crop and livestock products

The cumulative nutrient import-export of all dairy farms was calculated. Net N, P, K and C import via feeding stuffs was a major importation to four mixed farms as we alluded to above for each household. Table 4 shows the cumulative proportion of N; P, K and C imported via crop and livestock feeding stuffs for HH-1, HH-2, HH-3 and HH-4 with values as 64.7 %, 50.8 %, 87.3 % and 99.7 % of all nutrient imports, respectively whereas, exported as milk, animal live weight, dung cake and crop products were 35.3 % of N, 49.2 % of P, 12.7 % of K and 0.3 % of C of all N, P, K and C exports, respectively.

Input/output ration (Balance)

The whole farm balance expressed as N, P, K and C input/output ratios in four crop-livestock mixed operation in different HH under UPA of Kabul, are presented in Table 5. The values ranged from 1.2 – 4.1 of N, 0.8 – 1.9 of P, 4.4 – 20.4 of K and 117.8 –

Table 5: Nutrient N, P, K and C input/output ratio (balance) in crop-livestock mixed operation in UPA of Kabul, Afghanistan.

Household	N	P	K	C
HH- 1	2.4	1.6	8.9	6,624.6
HH- 2	4.1	1.9	6.6	117.8
HH- 3	1.9	0.8	9.4	361.4
HH- 4	3.2	1.8	20.4	312.0

3312.of C, as a whole results indicating that more nutrient were coming onto the farms than were being accounted for in the sale of product, exported crop and animal goods. Where, N lost from manure as ammonia was not measured in this study and consequently was not included in the surpluses estimation.

Among all, N surplus was higher in HH-2 followed by HH-4 and HH-3, while HH-1 showed the least N input/output ratio in the farm.

Differently P surplus was higher in HH-2 followed by HH-4, while HH-3 and HH-1 revealed highly deficit of P.

K was the third element following the similar trend of surpluses, higher in HH-4 followed by HH-3 and HH-2. HH-1 had the least input/output ratio.

The ratio of C reached maximum in HH-1 followed by HH-3 and HH-4, while HH-2 had the lowest ratio.

As a whole all farms revealed large surpluses of N, P, K and C in mixed operation circumstances except for P in HH-3 and HH-1 with input output ratio of 0.8 and 0.8 in diverse crop-livestock operated HH of Kabul city which revealed highly deficits in these two gardens.

DISCUSSION.

Changes in farm entities

Our scheduled weekly interviews revealed that we have reached to the point that, there was direct link between socio-economic status in farm entities (livestock number, feedstuffs, breed of the cattle, arable land, stall area per unit of livestock and productions of different entities), management method, intensity and nutrient input, are driven to some extent by income dependence on livestock and crop mixed farming operation. HH-1 was pressured to pursue intensive production because he had no own land and was paying rent yearly, consequently land was kept busy with fodder and forage production leaving no option for other crops. Furthermore, market was in favor for the animal products for this HH due to its strategic location, almost in the center of the city.

In HH-2, HH-3 and HH-4 local farmers were not pressured to pursue intensive farming because they had no land lease cost to pay and often had alternative sources of income from cereals (crop), fruit (grapes) and some vegetable production. They prefer keeping livestock with crop production which require less management and capital for buying forages and other supplements in their farms.

Finally the most changes in farm entities have been observed due to the economic strength of the HH. Additional returns led to extra investment which subsequently caused further positive changes in the farm products or adversely. Another reason for changes in farm entity (livestock products) is livestock breed, which local breed with low yield of 750 kg $year^{-1}$ (Bonnier, 2007) and high resistance to disease was preferred by some farmers in urban and peri-urban areas of the city. However, these changes are not comparable with high producing animals in the dairy production systems. This is the specific management method what we have found in the UPA of Kabul.

Livestock feeding pattern at different HH under UPA

Result for feeding pattern of livestock in our study revealed that, nature of stall feeding in confinements of the city was varied from feeding approach (feeding of wheat and rice straw alone with some natural grazing) of livestock around the city and rural areas. Our findings are not very much similar to those of Bonnier et al. (2007) who studied in the rural areas and he, furthermore, emphasized that better feeding resulted better yields. Possible reason for such a feed composition in urban area of Kabul may be referred to the availability of local sources of feed and supplements for livestock. For example in area around the city, buying of dry bread, cotton seed cake or other concentrate is not affordable by farmers due to their fragile economic conditions.

The prevailed dietary regime in the city was still deficient as compare to the livestock rations (alfalfa, corn silage, corn grain, protein, and mineral supplements) used in Wisconsin and Idaho dairies, USA reported by Powell et al. (2008); Hristov, et al. (2006).

Furthermore, the amount of DM offered for livestock in the farms of Kabul city ranged from 7.4 – 11.4 Kg DM/cow/day calculated for all livestock (calve and cows) was still less than of 18.8 -24.1kg DM of Wisconsin dairy farms. The differences may caused by the age of livestock in the stall or will be completed by a casual feed of grape leaves and aftermath of wheat straws used by farmers during the shortages of the feedstuff especially during spring season as mentioned in the methodology.

Nutrient imported into the farm via livestock feed vs crop inputs

Table 3 depicts N, P, K and C import to the dairies participating in this study which revealed, imported nutrients via feedstuff were the major imports to the farms with slight variation between farms. Total N imported via feed ranged 95.6 – 98.9 % in all farms. Values were still higher than the N imported of 77 % of total N imports via feedstuff in a confinement system of Nebraska, reported by Koelsch and Lesoing. (1999). This was also close to the result of Hristov et al. (2006) where, the 90 % of all N imported via feedstuff in Idaho dairy farms, USA. The forage type was inconsistent with diet of Idaho dairies (mostly alfalfa).

Similar to the N imports, P imported with feedstuff (84.0 - 99.8 %) was the major P import for all farms within the range of average P imported via feedstuff explained by Spears et al. (2003) and Koelsch and Lesoing. (1999). Furthermore, value for P was within the range of value for P (95 % via feedstuff) reported by Hristov et al. (2005). In this comparison, we have used those farms, who calculated whole farm balance, even though, the numbers of livestock are varied, it has been emphasized by Spears et al. (2003), that care should be taken in making comparison between study values from the literature because not all farms used the same breed, herd size and similar feeding pattern.

In addition, values of K imported via feedstuff (95.2 - 99.3 %) was higher than the values of 92 % of all K imports, imported via feedstuff in Idaho dairies farm again reported by Hristov et al. (2005).

In our study C imported via feedstuff ranged 95.4 – 98.0 % was the major source of C imports into the four urban farms of Kabul city. Mostly related to the output of farms, here it is possible to mention that, C of milk and live weight was not considered.

Nutrient export from the farm via crop-livestock products

The total proportion of N exported as milk, live weight, and dung cake, ranged from 97.7 to 100 % in four dairy HH of urban agriculture of Kabul presented in Table 4. Values for N exported still exceeded the values of N exported with livestock products in Idaho dairy farm (88 % for whole farm export), reported by Hristov et al. (2005). More detail in this regard due to the low number of lactating cows may not be appropriate for this article.

Total proportion of P and K exported as milk, live weight, dung cake from four dairy farms in Kabul ranged from 99.0 to 100 % and . 88.5 to 100 %, respectively. This is still higher than the values from the result of intensive farm in Idaho by exporting 93 % of P and 93.5 % of K via livestock products, was showed by Hristov et al. (2005). Possible reason for these minute increases in livestock production in Kabul, dung cake export is higher (64 % of the whole dung produced) in livestock stall with insufficient management system for the farm bio-wastes (bedding and urine). As a whole, animal products in four dairy farms of Kabul exceeded the exportation via animal products as compared to crop (forages and fruits), because forages produced in the farm mostly used by farm animals, especially in HH-1.

Import – export balance

Input-output ratio revealed very eccentric result of substantial flow of nutrient N, P, K and C in four farms of UPA of Kabul cities, possible reason for these increases, or surpluses, in crop-livestock mixed operation in Kabul may be referred to 1) nutrient rich fodder simultaneously, with the inter-city wastes for crop production in the dairy farms, 2) keeping livestock in very small portion of land with poor management of the bio-wastes in dairy HH. The nutrient surpluses in crop-livestock mixed farms of Kabul can be explained in point of view of finding by Cogger et al., no date; Hristov et al. (2006) in USA. Even though, crop-livestock management in USA is widely dissimilar from Kabul but principally inflow and outflow (whole farm balance) can be as an intact image for the comparability. Subsequently it may lead to the nutrient surplus or deficits. The surpluses event of the nutrient in the soil pool of dairy HH in Kabul city was also reported by Safi et al., 2010 in other trails of matter fluxes in UPA of Kabul.

As well as surpluses of P in diary farm confirmed by Koelsch. (2005), reported that, 1/3 units of P leaves of managed output the remaining two units are either lost to the environment or stored on the HH farm. Furthermore, P level in the manure amended soil of participating farms in UPA of Kabul again reported by Safi et al. (2010) exceeded the Idaho P recommended threshold level of 40 mg kg^{-1} for surface water, 30 mg kg^{-1} for soils where ground water is > 1.5 m from the surface and 20 mg kg^{-1} when ground water is <1.5 m from the surface (NRCS, 2007).

Owing to alluvial soil of farm area, leaching potential is also high in these sites. Annual NO_3-P, NO_3-N leaching in Kabul reached to 3.8 - 8.8 kg ha^{-1}, and 68.8 – 207 kg ha^{-1}, respectively, reported in previous study (Safi et al., 2010).

The average whole-farm K ratio was 11:1 higher than N and P ratio as we alluded to above. Again this was in consistent with finding of Hristov et al. (2006). it was also pointed out by Safi et al. (2010) in the earlier study that, K was highly deficit in the soil of HH-1 and HH-2 but was surplus about 5 kg/ha/yr in the HH-3, and HH-4, it can be implicated that, some feeding and application of inputs to the farm is the major route for K inflow in the farm, even though, there was no application of K with fertilizers during production process. To put these balances in perspective, we can compare these to surplus targets used in new regulation in the The Netherland which were still exceeded of 197 kg $ha^{-1}yr^{-1}$ (Cogger et al., revision of report, no date).

IMPLICATION

Normally crop-livestock producers in UPA of Kabul are responsible for balanced input (feed and fertilizer) for their animal and crops. Owing to, different socioeconomic status of the farmers, the preferred approach for achieving of this goal varied. Using animal dung cake as a source of fuel for cooking, inter-city wastes and chemical fertilizers for crop production are most likely strategy between urban farmers. This may lead to the balance application of the nutrient in the farm. Poor infrastructure of the farm can be diverting factor of this customary managed activity as it was seen in the four farms of the city. Generally it seems good but still exceeded nutrient inflows into the farm in contrast to the nutrient outflow off the farm. In spite of improving method of dung storage with suitable structure and optimum use of feed nutrients may enhance the balance in the crop-livestock mixed operation.

CONCLUSIONS

The N, P, K and C via feedstuff were the major important items; livestock products exported off the farm were major exports items on crop-livestock mixed operation in HH under study of UPA of Kabul, Afghanistan. The evaluation of whole farm import-export indicated net accumulation of N, P, K and C in the farm. In general, exports of nutrients via crop productions as compared to livestock production were insignificant to achieve whole farm balance and sustainability of the crop-livestock mixed operations. The inflow of N, P, K and C into the farm via feed mainly, and uses of inter-city wastes were partially responsible for the observed high build up of nutrient in the environment. This study demonstrated that, in spite of livestock product exports, optimum use of feed concentrates and export of nutrient with crop produced in the farm may help in diminution whole-farm N, P and K surpluses**.** In light of our result further investigations are required by involving more households under confinement operations in and around the Kabul city to improve farm infrastructures in chorus with major changes in nutrient management. Otherwise, the long term best management practices will not yield much to reduce the nutrient imbalances.

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