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RESEARCH ARTICLE

Characterization of the diversity of dairy farming systems and milk marketing strategies around greater Cairo (Egypt).

M. A. Radwan[1*], S. Abdelghany[1], C. Corniaux[2], Amal K. El-Asheeri[1], V. Alary[3]

1. Animal Production Department, Faculty of Agriculture, Cairo University, Giza, Egypt.
2. International Centre for Research in Agriculture and Development (CIRAD), Montpellier, France.
3. CIRAD/ICARDA (International Center for Agricultural Research in the Dry Areas**)**, Rabat, Morocco.

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Corresponding Author

M. A. Radwan.

Abstract

The aim of this study was to suggest a methodology to characterize the diversity of dairy farming systems in Nile valley lands (NVLs) and newly reclaimed lands (NRLs) in Egypt to understand the traditional dairy sector. Data were collected from 65 farmers in three villages through three consecutive seasons. Interviews and field visits were done at farm level. Based on multiple factorial and cluster analyses, six farmer groups were identified according to land and livestock assets, milk production and selling. Milk marketing was influenced by season, farmers' traditions, and market access. Structure highlights the dominance of small scale crop-livestock system, farm family depends on milk as a source of protein and fat for family food and as a main source of income especially in old lands, while in NRLs, there was a higher crop-livestock integration and complementarity to cover family and farm expenses, so paid services strategy could fit dairy sector in new land. Milk production constitutes a major activity in very small land farms, the sustainability of this sector facing the lack of technical support and lack of pricing system for milk and feedstuffs, where more governmental and non-governmental projects needed to supply farmers with high quality forage seeds, high producing animals and veterinary services. So, considering the diversity of farming systems, one agricultural policy will not fit all farmers' categories. Also, governmental and non-governmental services should be reasoned according to the region and the season.

Introduction:-

Crop/livestock system was the main system at the international scale, provides around 75% of dairy, 60% of meat and up to 50% of cereals production (Herrero *et al.*2010). Hahlani and Garwi (2014) reported that, milk production in small scale provides rural employment and cash incomes while at the same time helping in diversifying, intensifying and stabilizing agricultural production system.

Multifactorial analysis (MFA) was applied to characterize the diversity of farming systems (Alary *et al*, 2002). Cluster analysis allowed to identifying different farming systems in terms of structure (family composition, herd and land size) and function (the practices and strategies). This analysis help in developing target interventions through policies or advices for different types according to their assets and their functioning (Perrot and Landais, 1993 and Faye and Lhoste, 1999).

In Egypt, crop-livestock production system is considered as the main farming system including about 95% of bovine population (cattle and buffaloes); in this system, 84% of farmers had <3 feddans (1.3 ha) with 2-3 heads of animals;

buffaloes, native and crossbred cattle (Census, 2010). Crop-livestock production system provides about 75% of milk production at the national level, while 25% produced by commercial farms (Abdel Aziz and Sadek, 1999).

In Egypt, most studies focused on the differentiation between intensive production system which linked with modern dairy industry and small scale production systems (crop/livestock production system) which connected with traditional dairy sector. There is no study about the diversity of crop-livestock production systems and milk marketing strategies of small and medium dairy enterprises. The main goal of this study is to characterize the diversity of dairy farming systems in the selected villages and to understand milk marketing strategies of farmers regarding livestock products according to internal (family size, herd size and land size) and external factor (seasonality and pricing system). This will help to make proposals for policy makers, NGOs working in dairy sector and developers accounting for livestock farming systems diversity in Egypt and in other tropical and subtropical countries that have similar properties**.**

Materials and Methods:-

Three villages were selected: one village, El-Imam Malik located at 120 km north of Cairo, represents the NRLs and the other two villages; ElAtf and Reka villages that are located, respectively, at 50 and 80 km south of Cairo, represents the old system in the NVLs (Figure 1). Cluster analysis applied to differentiate farmer' categories according to their farming systems, their livestock orientations (meat or milk), their animal marketing systems and their localization regarding Cairo markets. In each village, around 21 farmers were selected with different milk marketing strategies. In total 65 farmers have been followed each season from winter 2013 to summer 2014 in the three villages. A small semi structure questionnaire developed to approach the farm structure (land and crop allocation, herd structure and composition, milk and veal marketing strategies). This questionnaire applied through three seasons (winter, spring and summer) to record changes in crop allocation, herd composition and animal products marketing pathways.

MFA has done using the 65 farmer's data that followed over 3 consecutive seasons. MFA, cluster analysis were applied using ascendant hierarchical classification (Manly 1994). All calculations performed using R software (R core team 2012) and the additional package ade4 (Thioulouse *et al.* 1997).

To understand the link between the functioning system of the family farms including family, crop land system, livestock system and integration of crop-livestock system and the animal marketing system (related to milk and meat products and the reasons), data were classified into 7 themes. The functioning of CLS was approached by 3 themes of family, herd and feed variables. Also, four other themes of variables were related to animal marketing orientation: included "milkcons", "Milksale", "veal" and "reasons" showed in Table 1. The percentage of milk consumed by calf was estimated by the number of udder quarters available for feeding calves; if 4 quarters available, so calf consumed 100% of milk, while one quarter means that calf consumed 25% of the dam milk.

Results:-

Diversity of crop-livestock systems:-

a) Multiple factorial analyses:-

The first factorial plan shows that milk marketing strategies were mainly linked to herd size and family milk consumption and this explained the first axis of differentiation (23.2%) in Figure 2a. The second axis differentiates farmers according to veal management practices in link with marketing opinions of farmers (16.1%). Feed and family appear significant only on third axis of the factorial plan (Figure 2b).

The links among the themes illustrated traditional farming systems characteristics. Feeding system was explained by the land and crop system. The orientations of animal products marketing between self-consumption or selling milk products linked to the herd size. At opposite, the strategies of veal marketing were more related to economic status.

b) Cluster analysis:-

Based on a hierarchical cluster analysis, four main groups and two little groups were identified. Figure 2 shows the cluster projections on the first factorial plan (1*2) and table 2 presents the classification of farms in each cluster according to their location.

In order to reflect the diversity of farming systems and to understand milk/veal marketing strategies according to farm size, two groups were kept contained only 3 farmers.

The main characteristics of these groups are presented in Table 3. The cultivated forage area was used to cover part of the animal nutritional requirements. The green fodder was berseem (Egyptian clover) in winter and horse grass and/or corn fodder in summer for all farmers.

Group 1: Large croppers (3%):-

This group gathered the large family size (10.5 persons in average). Farmers owned the largest cultivated lands (3.6 hectares). The herd composed of around 10 buffalo heads and 7 cows on average. The forage crops were represented 38.4% of cultivated lands over the year. Farmers depend on CFM by 93% of total feeding.

Herds included 6-7 lactating animals and 3 dry animals through studied seasons. Around 50% of buffalo milk and 70% of cow's milk production were sold. The farmers kept calves for breeding or fattening and consumed or sold about 25% of milk production, while the rest milk consumed by calf.

Group 2: Large breeder (1.5%):-

This group included only one farmer, which characterized by a family size of 7 persons. This farmer cultivated around 2.9 hectare of his own land. Forage crops represent 60.4% of cultivated lands over the year. The areas cultivated with cereals and vegetables represent 30.1% and 9.5% of total lands. CFM account 100% of total animal feedstuffs.

This farmer had the largest herd size (up to 32 heads) composed of 22 heads of buffalo and 10 heads of cows. Dairy herd contained 8-9 heads while dry animals were around 3-4 heads. More than 97% of produced milk sold. While veal calves were raised and consumed 50% of dam milk production through suckling period.

Group 3: micro CLS in OLs (38%):-

This group characterized by medium family size (7-8 persons). They cultivated the smallest area (0.6 hectares), where owned land represented only 26.1% of cultivated lands and the rest was rented. Forage crops represented near half of cultivated lands, while the areas cultivated with cereals and vegetable accounted for 23.7% and 26.1% of total lands. Farmers used CFM <50% of total feed.

Herd size didn't exceed 3 heads per farm, composed of 1-2 heads of buffaloes and one cow. Half of animals were lactating animals, where <50% of buffalo milk and 88% of cow's milk production sold. Also, Farmers tended to sell veal calves at early stage of lactation (on average 41 days), and calf consumed about 94% of dam milk production through suckling period.

Group 4: small CLS in OLs (12%):-

This group was characterized by large family size (10-11 persons) and considered as a subgroup of group 3 due to similarity of land size, proportion of rented land and feeding system. They had small cultivated lands (0.9 hectares) and the rented land accounted for 59.4% of total lands. Forage crops area represented two third of the cultivated lands, contrary to only 46.9% in group 3 and the other crops like cereals and vegetables accounted for 23.7% and 11.9% of total cultivated lands.

Herd size was about 5-6 heads with 4-5 buffalo heads and 1-2 cattle heads with a dairy herd counting 3-4 lactating animals and 2 dry animals. Farmers in this group tended to sell buffalo milk compared to cow milk (83.8% *vs.* 53.1% of total milk production). Sold veal at 36-37 days, which consumed around 85% of dam milk.

Group 5: Medium CLS in NRL (28%):-

This group was characterized by a large family size (9-10 persons). Cultivated around 2.3 ha owned land some farmers extended cultivated lands through renting more lands (< 50% of total lands). Forage crops represented around 30% of cultivated lands while the cereals and vegetables represented 20.8% and 37.5% of total lands. Farmers feeding animals with corn and wheat bran while CFM represent lower quantity (< 30% of total feeding).

Herd size was about 5-6 heads composed of 2-3 buffaloes and 3 cows, with 2-3 lactating and 1-2 dry animals. Farmers consumed the majority of the milk production and sold only 12% and 44% of buffalo and cow milk. Farmers sold veal with an average age of 41 days which consumed 82% of dam milk.

Group 6: Small-medium CLS oriented to cash crops (17%):-

This group was characterized by a medium family size (7-8 persons). This group gathered farmers from North and South villages. In the North, they cultivated around 1.0 ha and in the south they rented around 57.4% of total cultivated lands. Forage crops were about one third of total lands, cereals and vegetables represent around 25% and 30% of total lands.

Group 6 had a small herd size around 2-3 heads composed of 1-2 buffaloes and 1-2 cows, with 1.5 lactating animals. 23.6% and 59.7% of milk production from buffalo and cattle were sold. Farmers sold veal with an average age of 44-45 days which consumed 95% of dam milk.

Milk seasonality and milk marketing:-

a) Milk production affected by seasonality and species:-

Figure 4 showed the rate of buffalo calving increased in winter season and decreased in spring and increased again at the end of summer season. There was a similarity between cows and buffaloes in calving frequency pattern. Milk production affected by season milk yield registered a peak in cold season and a fall in hot season (Lambertz *et al.*, 2014).

Buffalo produced more milk in winter (7.3 kg/day/head) compared to (6.5 kg/day/head) in spring and (5.2 kg/day/head) in summer. The same trend found in most cluster groups, except in group 2 (large breeders, Table 4). Table 5 represented the cow milk production which record the highest level in winter (7.7 kg/day/head), followed by summer (5.2 kg/day/head) and spring season (4.7 kg/day/head). This trend is matched with results in Figure 4 where the high calving occurred in winter and summer season. Cluster groups present the same trend except for small CLS in OLs (group4) and small CLS oriented cash crops group (group6) where cattle milk production decreased in summer.

b) Milk marketing seasonality:-

Quantity of milk collected and sold in summer was lower than in spring and winter. Table 6 shows that trend is confirmed for all groups and the peak of sold buffalo milk was in spring after calving and suckling, and before the hot climate at summer (Figure 5). Amount of selling milk was decreased to <50% in summer for all cluster groups except small CLS in OLs group and large breeders group.

Figure 5 showed the different place of milk in the farming system between the OLs in the south and the new lands in the north.

Variability of marketing strategies of milk according to different farming systems:-

a) Internal and external factors of milk marketing strategies:-

Available quantity of fresh milk on the markets varies also in function of farmers' tradition and endogenous knowledge. Data collected confirmed that, due to hot temperature, milk is usually processed in cheese and butter during winter and stored for the whole year especially in small scale farms. By preference, family farms kept buffalo milk for both consumption and processing, this explains the lower quantity of buffalo milk in the market (Figure 6).

In NRLs, milk traders deal frequently with cheese processing units didn't valorize well the buffalo milk compared to cow milk with lower fat%; so farmers prefer selling cow milk and keep buffalo milk for family consumption and/or for consumers in the village (short chain). This explains partially the decrease of the buffalo population in these NRLs. In Reka village, the activity of one milk collection center changed the milk valorization at the family level; now skimmed milk is collected with reasonable price and women keep the cream to produce butter and cheese for the family or village market.

Milk traders are the common buyers of fresh milk for both in ElAtf and Imam Malik villages. While in Reka, MCPs and MCC are common. However, local market and neighborhood are considered a good outlet with a good valorization.

b) Veal and milk marketing strategies:-
Figure 7 showed that farmer's behavior tend to sell more veal in summer (87%) than in winter and spring (73%) as a strategy to save milk for human. Moreover, the sold percent increase in summer season because the shortage of buffalo milk.

Raising veal could be viewed as a competitor with milk marketing due to the milk consumption by calves during the more productive seasons like winter and beginning of spring. This clearly appeared in the traditional mixed crop-livestock systems representing in the groups 3 to 6 where the milk consumed by the veal represented around 80 to 95% of milk production. In the medium dairy farms representing in groups 1 and 2, farmers keep the veal.

Discussion:-

MFA shows clearly the dominance of CLS in the OLs (NVLs) and NRLs in west Delta. This system is based on the allocation of lands between fodder and food crops; green fodder and grains were the main components of herds feed ration, plus crop residues from food and cash crops. Wheat bran as industrial by product is intensively used in new and old lands because its reasonable price and larger volume of the same unit weight compared with alternatives. Also, manure is directly applied on the land; and veal value used to finance annual expenses like rent land or animal investment.

However, it's clearly observed a regional diversity between OLs and NRLs due to the land access. Traditional farming system in OLs didn't exceed 1 ha, while the majority of farmers in NRLs get around 2.28 ha. So the animals charge per ha is between 3 and 11 animals in OLs, compared to 2-3 animals/ha in the NRLs. These variations will affect the needs of each group and each region for services and development projects. NRLs may need a balanced services for both livestock and other agricultural activities. While, OLs needs more low cost services to be sustained and very tight vaccination and biosecurity programs to protect livestock which considered the main source of income and the main protein source for families.

The second criterion of differentiation is the herd composition between buffalo and crossbred cow. In OLs, farmers tended to rear more buffaloes for milk that is well valorized on the market, compared to farmers in NRLs that prefer raising crossbred because buffalo milk is not well valorized on the local market. Also the significant forage production of OLs encouraged farmers to supply buffalo with sufficient nutrients to produce milk with high fat and protein percent that has high value and less quantity compared with raising crossbred cows. For the two villages of OLs, this can be explained by the proximity of Cairo where buffalo milk can be sold7-8 EGP/liter in 2014, while milk traders acting in the village of the NRLs sold traditionally milk to a cheese processing units with lower price. Another criterion of differentiation is the crop allocation between fodder crops, cereal crops, vegetables and trees that depends on the size of cultivated area and cash crop orientation.

Many farmers in NRLs tended to increase the number of livestock especially cows to deal with the high fluctuation of vegetables and fruits price in the local market , also to provide daily income and high quality organic fertilizer for land which will decrease the need for buying more chemical or organic fertilizers.

Most of buffalo breeders sold veal to save milk and to get a quick source of money. Sometimes, farmers use the crossbred cows to suckle buffalo veal, which will decrease the cost of rearing buffalo calves and increasing the revenues of selling more buffalo milk. The marketing decision between veal and milk can vary from one year to another according to family needs. For land renters they usually rear and sell their veal to cover the cost of renting land. More generally, most of them were depending on milk as family food and as a daily cash income (Ngongoni *et al.*, 2006).

One common characteristic for milk selling strategy is marketing seasonality, where the peak of milk marketing was spring for all groups and this in link with the calving and suckling periods in winter and the reduction of milk production in summer due to hot temperatures; where less availability of forage quantity and quality and most lactating animals at the end of lactation or started to be dried. Moreover, winter season corresponds to the period of transformation of milk in butter and cheese to cover the family demand along the year.

Two types of dairy chains were identified, the first is the very short chain where farmers sold directly to consumers; the second is medium chain where farmers sold milk to middle men who sell to cheese processing units, retailers

like dairy shops or consumers. In 2013/2014, the highest milk price was observed when farmer sold directly to consumer in a very short dairy chain.

There are many financial and institutional constraints that affect the sustainability of these CLS. Financial constraints like loans availability for farmers as an aid to rent more lands. Selling veal is one strategy to deal with financial constraint; farmers tended to sell veal to earn money to cover part of land rent cost. Instead of selling veal that could be kept as a capital source to cope with financial crisis. Moreover, this study showed that most farmers in OLs cultivated lands mainly with forage to feed livestock, so high quality forage seeds should be introduced by cooperatives to cover both quality and quantity nutritional gap of dairy cattle. There was a gap of energy in winter, where the main forage is Egyptian clover, while protein supplement or legume forage needed to cover the protein source in winter. Also, most farmers are not adding minerals and vitamins for cattle. Fertility management and AI programs should be conducted in winter and spring seasons, where most dairy cattle are inseminated at these seasons. Vaccination programs for dry cows and buffaloes should be introduced in summer where most cattle are dry. Feeding extension services for transition cattle should be introduced by the beginning of winter, where most cattle calved at this time. Women training for milk processing should be introduced in winter where most of milk processed. It's very vital for dairy farming sustainability to introduce new economic activities such as poultry raising, traditional food processing or some simple home made goods especially in summer, where no or low income of dairy enterprise.

Table 1: list of variables per theme used in the present study

Theme	**Variables**	
Family size 'family'	Family size	No. of hectares rented by farmer
	Occasional labor	Total cultivated area by farmer
	Permanent labor	No. of hectares cultivated by forage crop
	No. of hectares owned by farmer	
Herd size 'herd'	No. of dairy animals in winter, spring and summer per farmer	No. of buffalo in winter, spring and summer
	No. of dry animal in winter, spring and summer per farmer	No. of bovine in winter, spring and summer
Feeding 'feed'	Quantity of CFM[a] in winter, spring and summer kg/day	Quantity of wheat bran in winter, spring and summer kg/day
	Quantity of corn in winter, spring and summer kg/day	Quantity of cotton seed cake in winter, spring and summer kg/day
Milk consumption 'milkcons'	Buffalo milk production / farmer in winter, spring and summer kg/day	Bovine milk consumption / farmer family in winter, spring and summer kg/day
	Cattle milk production / farmer in winter, spring and summer kg/day	Buffalo milk consumed by drinking / farmer family in winter, spring and summer kg/day
	Buffalo milk consumption / farmer family in winter, spring and summer kg/day	
Milk sale 'milksale'	Quantity of buffalo milk sold / farmer in winter, spring and summer kg/day	Quantity of buffalo milk sold to trader kg/day
	Quantity of cattle milk sold / farmer in winter, spring and summer kg/day	Quantity of cattle milk sold to collection point kg/day
	Quantity of buffalo milk sold to collection point kg/day	Quantity of cattle milk sold to milk collection center kg/day
	Quantity of buffalo milk sold to milk collection center kg/day	Quantity of cattle milk sold to neighbor kg/day
	Quantity of buffalo milk sold to neighbor kg/day	Quantity of cattle milk sold to trader kg/day
Veal 'veal'	Veal age through winter, spring and summer season	Proportion of veal through winter, spring and summer(first 10 day after birth)
	Veal price through winter, spring and summer seasons	Proportion of milk consumed veal through winter, spring and summer(after first 10 day after birth)
Reason 'reasons'	The reason to deal with trader	The reason to keep veal or sold
	The reason to sell milk or keep it	

[a]CFM= concentrate feed mixture.

Table 2: Cluster group and number of farmers in each group.

Cluster Groups	Large croppers	Large breeder	Micro CLS[a] in old land	Small CLS inold land	Medium CLS inNRL[b]	Small-medium CLS oriented cash crops	Total
Group No.	1	2	3	4	5	6	
Village:							
Elatf	1	1	8	4	4	1	19
Reka			16	4	1	4	25
El-Imam Malik	1		1		13	6	21
Total	2	1	25	8	18	11	65

[a] CLS: crop/livestock system; [b] NRL: Newly reclaimed land.

Table 3. Mean and Standard deviation (SD) of the main variables characterizing each cluster group (average of three seasons).

Item	Cluster Group					
	Large croppers	Large breeder	Micro CLS[a] in old land	Small CLS in old land	Medium CLS in NRL[b]	Small-medium CLS oriented cash crops
	1	2	3	4	5	6
Family size (person)	10.5	7.0	7.9	10.4	9.8	7.5
	(6.4)		**(4.4)**	**(5.0)**	**(4.9)**	**(3.2)**
Cultivated land (hectare)	3.6	2.9	0.6	0.9	2.3	1.0
	(1.5)		**(0.8)**	**(0.7)**	**(1.7)**	**(0.9)**
Fodder area (% cultivated land)	38.4	60.4	46.9	64.3	29.7	35.4
	(24.8)		**(20.4)**	**(27.1)**	**(30.5)**	**(26.1)**
Cereals area (% cultivated land)	33.0	30.1	28.70	23.7	20.8	24.9
	(30.8)		**(20.5)**	**(22.9)**	**(19.5)**	**(27.6)**
Vegatables area (% cultivated land)	14.4	9.5	23.7	11.9	37.5	29.5
	(19.1)		**(24.8)**	**(13.4)**	**(30.6)**	**(24.1)**
Owned land (% cultivated land)	100	100	26.1	40.6	54.0	42.6
	(0)		**(38.5)**	**(30.7)**	**(42.0)**	**(47.3)**
Rented land (% cultivated land)	0	0	73.9	59.4	40.1	57.4
	(0)		**(38.5)**	**(30.7)**	**(42.0)**	**(47.3)**
Landless (% in the sample)	0	0	0	0	5.9	0
Herd size (No. of heads)	17.0	32.0	2.2	5.7	5.4	2.8
	(4.2)		**(2.7)**	**(3.2)**	**(3.5)**	**(2.0)**
Buffalo[c] (No. of heads)	10.0	22.3	1.4	4.2	2.4	1.2
	(2.4)		**(1.9)**	**(1.7)**	**(1.5)**	**(0.7)**
Cattle[c] (No. of heads)	7.0	9.7	0.8	1.5	3.0	1.6
	(5.4)		**(1.8)**	**(2.6)**	**(3.7)**	**(2.1)**
Lactating animals (No. of heads)	6.5	8.3	1.5	3.4	2.4	1.5
	(1.2)		**(0.9)**	**(1.9)**	**(1.7)**	**(0.9)**
Dry animals (No. of heads)	3.0	3.5	1.4	2.0	1.3	1.3
	(1.7)		**(0.7)**	**(1.5)**	**(0.8)**	**(0.6)**
Total feeding animal (kg/head/day)	4.3	5.2	4.9	4.8	5.0	4.6
	(1.3)	-	**(1.8)**	**(1.3)**	**(1.6)**	**(1.0)**
CFM[b] (kg/head/day)	4.0	5.2	2.8	2.7	2.1	2.1
	(1.6)		**(1.7)**	**(1.0)**	**(1.6)**	**(0.7)**
Corn (kg/head/day)	0	0	1.7	2.0	2.2	1.8
			(0.8)	**(0.9)**	**(1.3)**	**(1.1)**
Wheat bran (kg/head/day)	0.5	0	2.1	1.8	2.5	2.0

			(1.4)	**(0.6)**	**(1.3)**	**(0.8)**
Buffalo milk production (kg/day)	27.9	46.0	8.9	21.3	8.1	6.6
	(16.4)		**(7.1)**	**(9.8)**	**(4.9)**	**(2.5)**
Buffalo milk production (kg/head)	6.2	9.2	6.7	7.4	5.9	6.3
	(1.9)		**(1.4)**	**(0.9)**	**(1.9)**	**(2.0)**
cattle milk production (kg/day)	12.3	30.7	5.2	6.9	7.4	4.6
	(1.9)		**(2.3)**	**(3.6)**	**(2.4)**	**(1.4)**
cattle milk production (kg/head)	5.0	6.3	4.2	5.9	5.8	4.4
	(0.8)		**(1.8)**	**(3.6)**	**(1.3)**	**(1.1)**
% of buffalo milk sold	56.8	97.3	48.6	83.8	11.9	23.6
	(56.9)		**(40.9)**	**(15.7)**	**(31.7)**	**(33.2)**
% of cattle milk sold	71.3	98.4	88.0	53.1	44.1	59.7
	(40.7)		**(43.0)**	**(50.3)**	**(43.4)**	**(19.1)**
Veal marketing age (day)	0	0	41.2	37.0	41.7	44.5
			(6.6)	**(7.0)**	**(2.9)**	**(17.1)**
Proportion of milk consumption by calf (%)	75.0	50.0	94.0	86.2	82.5	94.8
	(7.1)		**(13.5)**	**(14.3)**	**(17.6)**	**(9.2)**

[a] CLS: Crop/Livestock System; [b] NRL: Newly Reclaimed Land; [c] Including all categories (dairy, dry, heifer, calf, fattening animals); [d]CFM: Concentrate Feed Mixture. Values between brackets = the standard deviation

Table 4: Daily milk production (kg) per lactating buffalo (mean & SD) for different cluster groups through winter, spring and summer seasons.

Cluster groups	**Group No.**	**Milk production (kg/head/day)**					
		Winter	**±**	**Spring**	**±**	**Summer**	**±**
Large croppers	1	7.6	2.3	6.1	1.5	4.7	1.8
Large breeder	2	9.5		11.4		6.7	
Micro CLS[a] in old land	3	7.7	1.8	6.3	1.4	5.2	1.8
Small CLS in old land	4	7.4	1.7	7.3	1.2	6	1.3
Medium CLS in NRL[b]	5	6.4	2.0	5.9	2.5	4.6	1.4
Small CLS oriented cash crops	6	6.7	2.1	6.6	2.4	3.5	1.7
Over all mean		7.3	2.0	6.5	2.0	5.2	1.9

[a] CLS: crop/livestock system; [b] NRL: Newly reclaimed land.

Table 5: Daily milk production (kg) per lactating cow (mean & SD) for different cluster groups through winter, spring and summer seasons.

Cluster groups	**No group**	**Milk production (kg/head/day)**					
		Winter	**±**	**Spring**	**±**	**Summer**	**±**
large croppers	**1**	5		3.2		5.3	0.4
Large breeder	**2**			3		7	
Micro CLS[a] in old land	**3**	5		3.1	1.8	3.5	2.1
Small CLS in old land	**4**	6.5	4.9	6.5	--	2.2	1.2
Medium CLS in NRL[a]	**5**	8.3	1.3	3.9	2.1	6.6	2.1
Small CLS oriented cash crops	**6**	8		5.3	2.1	3.2	1.4
Over all mean		7.7	3	4.7	3.2	5.2	2.9

[a] CLS: crop/livestock system; [b] NRL: Newly reclaimed land.

Table 6: The quantity of buffalo milk sold (kg) per day and per farm in each cluster groups through winter, spring and summer seasons.

Season	Cluster groups					
	Large croppers	Large breeder	Micro CLS[a] in old land	Small CLS in old land	Medium CLS in NRL[a]	Small-medium CLS oriented cash crops
Winter	**36**	**37**	**67.5**	**142**	**--**	**7**
Spring	**59.5**	**79.5**	**63**	**167.8**	**46.5**	**12**
Summer	**17.5**	**19**	**15**	**65.3**	**18.5**	**--**

[a] CLS: crop/livestock system; [b] NRL: Newly reclaimed land.

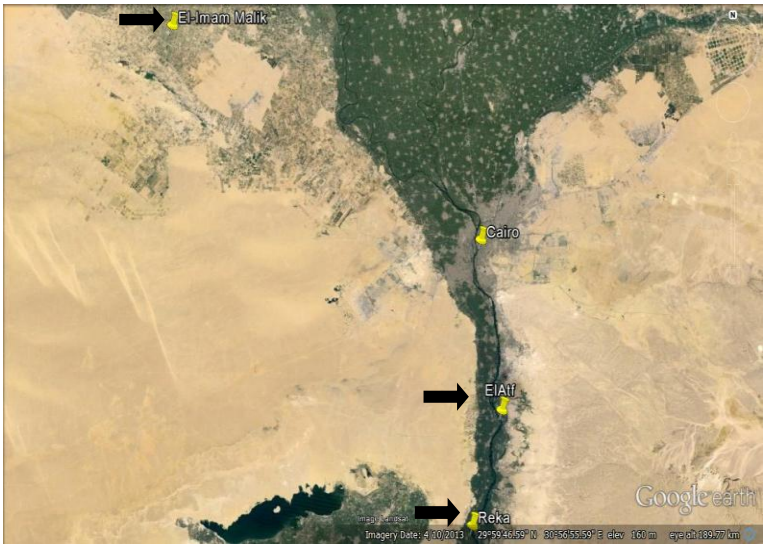

Fig. 1 Villages location of in the Egypt map (El-Imam Malik, El-Atf and Reka). Source: Google Earth scale 189.77 km.

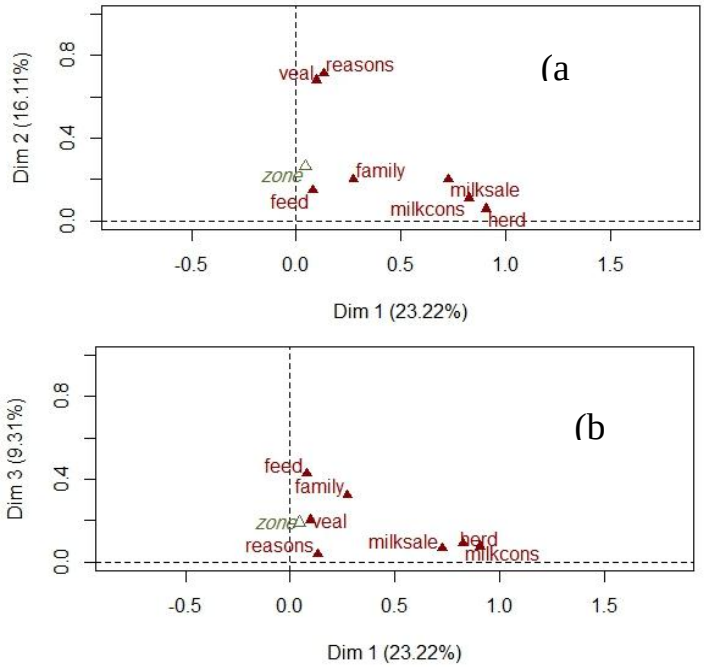

Fig. 2 Factorial analysis output; a: the relation between Dim 1 and Dim 2; b: the relation between Dim 1 and Dim 3.

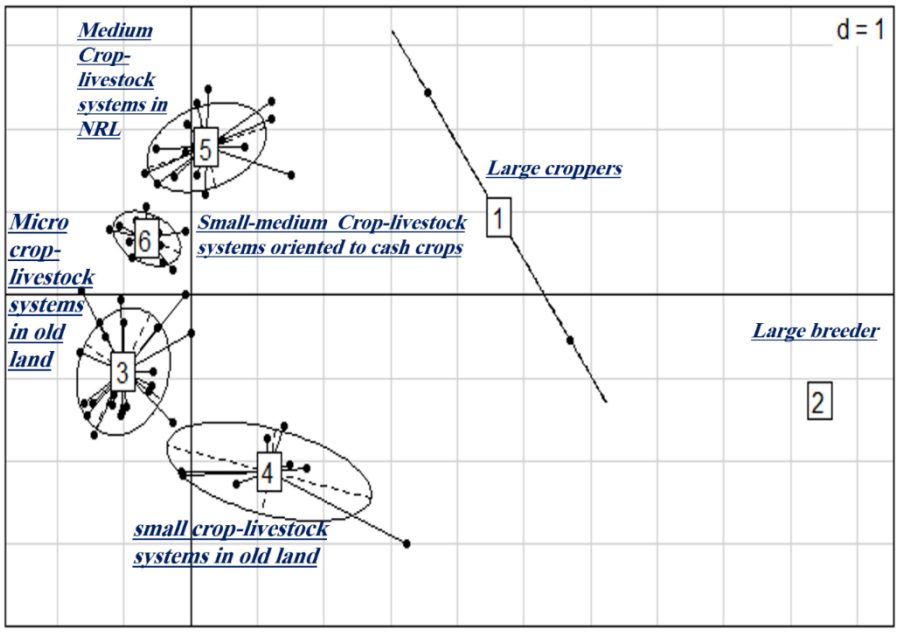

Fig. 3 Clusters projection on the first factorial plan (1*2).

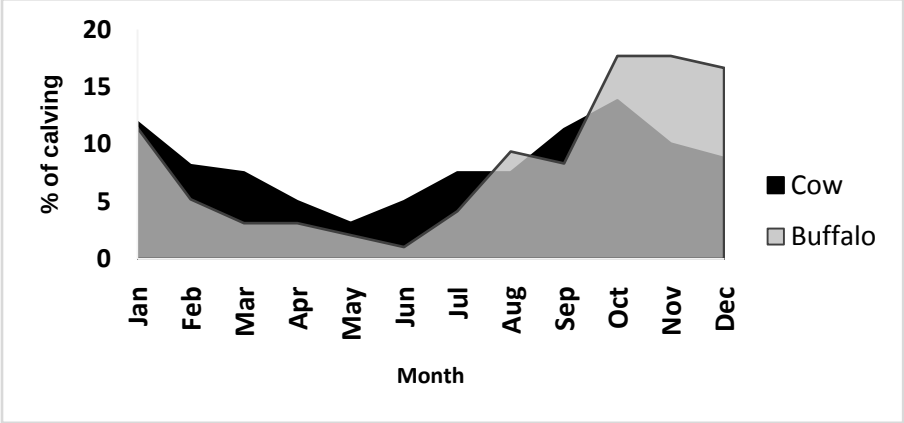

Fig. 4 The proportion (%) of buffalo and cattle calving per each month.

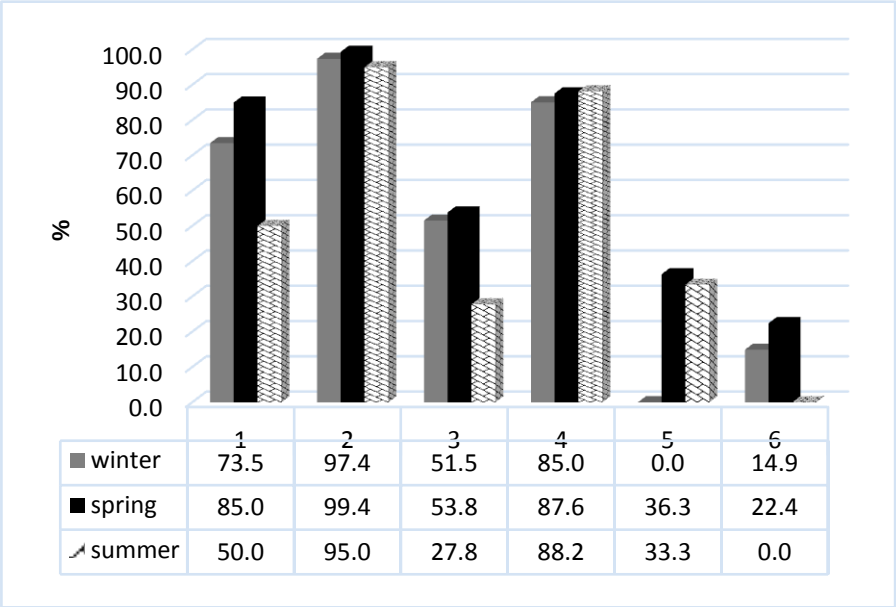

Fig. 5 The percentage of buffalo milk sold per cluster groups (1: large croppers, 2: large breeder, 3: micro CLS in OLs, 4: small CLS in OLs, 5: medium CLS in NRL, and 6: Small CLS oriented cash crops) per season (winter, spring and summer).

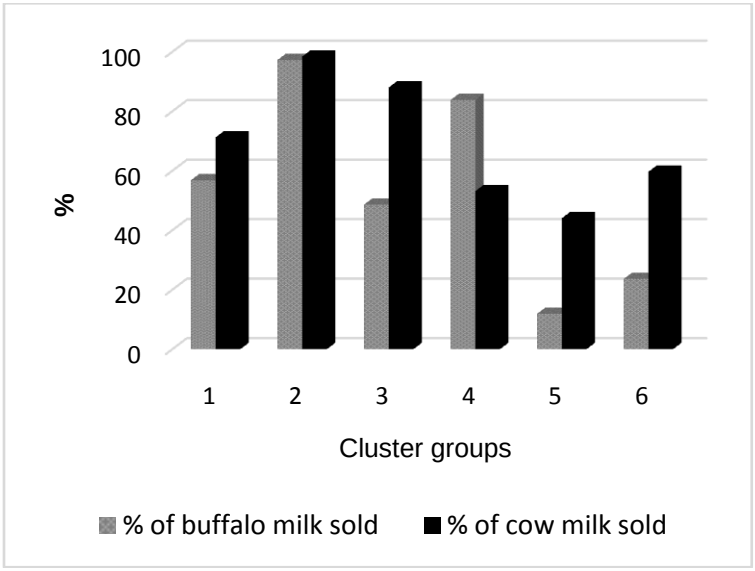

Fig. 6 Percentage of buffalo and cattle milk sold per cluster groups (1: large croppers, 2: large breeder, 3: micro CLS in OLs, 4: small CLS in OLs, 5: medium CLS in NRL, and 6: Small CLS oriented cash crops).

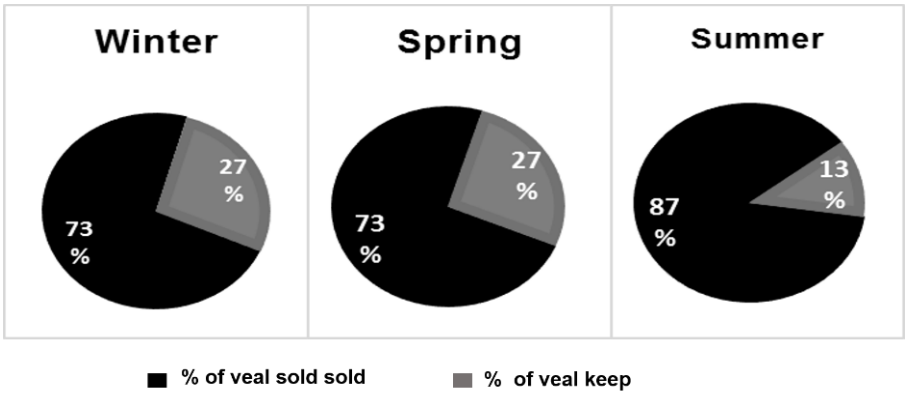

Fig. 7 The proportion of farmers sold veal vs. keep veal in three seasons.

Conclusions:-

Considering the diversity of farming systems, one agricultural policy will not fit all farmers' categories. Governmental and non-governmental projects are needed to supply farmers with high quality forage seeds, high producing animals and vet services with reasonable cost to improve sustainability of these farming systems. Also, services should be adapted according to the region and the season.

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Conflict of Interest Statement:-

Authors confirm that there is no conflict of interest

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