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par

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Sustainability of agro-pastoralist systems undergoing global changes as reflected by farmers' perception and value chain analysis: a Lebanese case-study

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Durabilité des systèmes agropastoraux soumis aux changements globaux reflétée par l'analyse de la perception des pasteurs et de la filière: une étude de cas libanaise

Mots-clés: durabilité, agro-pastoralisme, parcours, perception des pasteurs, filière, Liban.

Sustainability of agro-pastoralist systems undergoing global changes as reflected by farmers' perception and value chain analysis: a Lebanese case-study

Keywords: sustainability, agro-pastoralism, rangeland, farmers' perception, value chain, Lebanon

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Travail réalisé

sous la responsabilité scientifique de

J-F. Tourrand et avec le co-encadrement de S. Hamadeh

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DEDICATION

To my loving father Ghassan, my all-time supporter and friend,

To my husband Jean, my best friend, the gin to my tonic,

To my beautiful Maria…I see a bright future in your big round eyes!

Thank you for your love, strength and patience!

To the soul of my grandmother Meybol, my idol.

Mabelle

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SUMMARY IN FRENCH

INTRODUCTION

Le changement global est un processus complexe englobant les changements environnementaux, climatiques, sociaux, économiques, culturels et politiques. Il s'agit d'un ensemble de différents facteurs interconnectés qui peuvent être considérés comme des causes ou des conséquences (Last, 1993). Ces «méta-facteurs» de changement comprennent de nombreux facteurs tels que la croissance démographique, l'augmentation des migrations, les nouvelles demandes sociales, le développement industriel, le déficit structurel de la sécurité alimentaire, le changement climatique et la variabilité climatique, la pollution et la dégradation de l'environnement, l'épuisement des ressources naturelles, la transformation politique, le développement régional, le développement et la mise en œuvre de nouvelles technologies, l'instabilité financière, etc. (Haan et al., 2002; McMicheal, 2013; Daoud et al., 2016; Dong et al., 2016). Par la suite, des préoccupations sont soulevées sur la façon de produire suffisamment de nourriture pour répondre à la demande alimentaire mondiale d'une population humaine en croissance rapide tout en préservant les ressources naturelles et sous la pression du changement mondial (Haan et al., 2002).

Le changement mondial a toujours causé une grande pression sur le pastoralisme dans le monde et son impact indésirable continuera à ajouter du stress sur les systèmes pastoraux (Dong et al., 2016). Des facteurs de changement spécifiques compromettant la durabilité des systèmes pastoraux ont été identifiés au Liban et décrits dans le premier chapitre de cette thèse; ce sont i) le manque de politiques et de lois liées au pastoralisme et au régime foncier; ii) l'urbanisation et la migration rurale; iii) l'empiètement par l'agriculture; iv) la déforestation et le surpâturage; v) le manque de compétences techniques et de données pour la gestion des parcours; et vi) la variabilité climatique. Le poids de ces facteurs (et probablement d'autres) sur les systèmes pastoraux se traduit par une diminution des ressources des parcours en termes principalement d'eau et d'alimentation, une pénurie de nutriments due à la conversion des pâturages, un passage à des systèmes plus sédentaires, des changements dans les pratiques sociales, une diminution du nombre d'animaux et de troupeaux et même l'abandon des activités agricoles (Ben Salem et Smith, 2008; Dick et al., 2008; Daoud et al., 2016; Chedid et al., 2018).

Néanmoins, les systèmes pastoraux connus pour leur grande résilience, ont développé des mécanismes adaptatifs (Hamadeh et al., 1999 ; Kratli et al., 2013) qui, associés à des politiques locales adéquates, permettent à ces systèmes de surmonter les défis et donc de maintenir les moyens de subsistance de leurs communautés (Daoud et al., 2016). Ces mécanismes ont été largement documentés dans le monde entier et comprennent entre autres la diversification des activités génératrices de revenus à la ferme et hors ferme, la réduction de la taille globale du troupeau, la mobilité restreinte, la supplémentation

alimentaire, etc. (Hamadeh et al., 1999; Ben Salem et Smith, 2008; Dick et al., 2008; Alary et al, 2016).

Pour réduire la vulnérabilité des systèmes pastoraux et accroître leur résilience au changement global, les réponses des systèmes pastoraux et leurs mécanismes d'adaptation aux facteurs de stress doivent être analysés et compris (Dong et al., 2016). L'inclusion des agriculteurs dans l'élaboration des politiques et la planification des programmes, est également impérative pour la réussite des plans de développement et doit donc être prise en considération.

Sur la base de ce qui précède et de notre spéculation selon *laquelle les agro-pastoraux dans des régions contrastées du monde sont confrontés à des défis similaires et partagent les mêmes préoccupations, mais leurs stratégies d'adaptation sont affectées par leur contexte local qui améliore ou affaiblit leur durabilité*, l'objectif de cette recherche est d'évaluer la durabilité des systèmes agro-pastoraux au Liban qui subissent des changements mondiaux.

Par conséquent, les principales questions de recherche se répartissent en quatre grandes rubriques :

1. Quels sont les changements mondiaux qui affectent la durabilité des systèmes agro-pastoraux au Liban ?

2. Comment les agriculteurs perçoivent-ils ces changements et quelles sont les stratégies d'adaptation qu'ils développent en réponse à ces défis ?

3. Comment la durabilité des systèmes de petits ruminants se reflète-t-elle dans la filière du « kishk », fromage traditionnel préparé avec du lait de chèvre ?

4. Le cas Libanais est-il comparable à d'autres contextes dans le monde ?

Répondre à ces questions validera ou non notre hypothèse, et les résultats obtenus devraient offrir un outil utile aux acteurs du développement concernés (ministères et agences de développement) pour définir les moyens d'intervention afin de renforcer la durabilité de l'agro-pastoralisme traditionnel en rupture sous l'effet du changement global. Il a été démontré que les efforts de planification et de réduction des risques ne suffisent pas pour aider les agro-pastoraux à faire face aux menaces externes, mais il serait plus efficace de permettre et de renforcer leur capacité d'adaptation innée et de les aider à être plus autonomes plutôt que de leur fournir des stratégies d'adaptation.

REVUE DE LA LITERATURE

Chapitre 1 : **Défis des systèmes agro-pastoraux dans la région Arabe aride: une étude de cas du Liban** (Ce chapitre a été accepté pour publication dans le livre intitulé «Livestock Policy book» édité par UFRGS University Editions, Brésil).

La première question de recherche sert de point de départ pour identifier les changements globaux qui affectent la durabilité des systèmes agro-pastoraux au Liban. Pour répondre à cette question, un examen approfondi de la littérature, y compris des rapports, des publications scientifiques et d'autres documents pertinents, a été effectué. Les résultats qui sont présentés au Chapitre 1, montrent d'importants changements adaptatifs dans les systèmes de production au fil du temps, notamment : la diversification des revenus par le biais d'activités non agricoles, la réduction de la taille du troupeau et une transhumance limitée. Un abandon complet de la production animale a également été observé dans la vallée de la Béqaa au Liban, et certains agriculteurs ont opté pour une source de vie totalement différente. Les défis auxquels sont confrontés les systèmes d'élevage pastoral restent largement ignorés, bien que la demande de produits animaux augmente régulièrement, en raison de la croissance démographique et de la richesse accrue. Des politiques favorisant l'accès aux pâturages et à la réhabilitation des parcours sont absolument nécessaires, en plus des services financiers, vétérinaires et techniques.

MATERIELS ET METHODES

Chapitre 2 **: Matériel et méthodes**

Le deuxième chapitre décrit la zone d'étude (Bekaa Ouest et Chouf) et justifie sa sélection pour cette étude. Le cadre de la méthodologie utilisée est défini et les différentes méthodologies de collecte et d'analyse des données sont justifiées. L'approche de la recherche était à la fois quantitative et qualitative basée sur des données empiriques recueillies à partir d'enquêtes et d'études de cas et des données secondaires recueillies à partir de la littérature révisée, de courts métrages et de données en ligne (sites Web de confiance).

Il est important de souligner que la méthodologie utilisée dans ce projet diffère des approches traditionnelles utilisées pour évaluer la durabilité. Cette méthodologie peut être proposée comme un cadre de recherche innovant pour évaluer la durabilité ; elle comprend différentes méthodes telles que i) l'analyse de système, ii) la perception, iii) l'analyse de filière et iv) l'analyse de courts métrages, combinées ensemble pour servir l'objectif de ce projet de recherche.

La collecte de données fut réalisée sur trois niveaux :

i. La revue de la littérature : Un examen de la documentation disponible concernant le sujet de recherche a permis de mieux comprendre les aspects

théoriques et de recherche du sujet. Il a permis une comparaison entre plusieurs études de cas et a fourni plus d'informations sur les différents concepts qui sont abordés dans ce projet de recherche. La littérature révisée comprenait des articles scientifiques, des livres publiés, des rapports de projet, des sites Internet en plus des statistiques et des données publiques, etc.

ii. Les enquêtes : La phase préparatoire de ce projet de thèse comprenait plusieurs consultations avec des collègues de l'Université Américaine de Beyrouth, de l'Université Libanaise - Faculté des sciences agricoles et vétérinaires, du Centre de recherche agricole (ARC) - Institut de recherche sur la production animale en Égypte, du Cirad en Montpellier - France (unités GREEN et SELMET), l'Institut Agronomique Méditerranéen de Montpellier (IAMM) etc. pour échanger des points de vue sur ce projet et les travaux pertinents ainsi que les méthodologies de collecte et d'analyse des données. Ces consultations avec des personnes travaillant soit en recherche ou en développement ont été très utiles pour définir le cadre de la question et de l'hypothèse de recherche.

   La collecte des données primaires a été effectuée par le biais de deux enquêtes, chacune faisant partie d'un projet de recherche différent auquel j'ai participé. Les deux projets de recherche ont servi la thèse et visaient à enquêter sur les questions de recherche; le premier projet a étudié la question de la durabilité des systèmes d'élevage des petits ruminants dans la Béqaa Ouest, leurs défis et leurs stratégies d'adaptation, du point de vue des agriculteurs. Le deuxième projet visait à évaluer la durabilité de ces systèmes, comme en témoigne la filière du «kishk», un fromage typique qui est traditionnellement produit à partir de lait de chèvre dans la Béqaa Ouest et la région du Chouf.

   Une troisième enquête a été menée parallèlement aux deux précédentes et visait à collecter des données sur les systèmes de production laitière familiale dans la Béqaa Ouest et le Chouf. À la lumière des données très limitées sur les systèmes de production laitière familiale au Liban, l'objectif de cette enquête était d'identifier les différents types de ces systèmes qui existent dans la Béqaa Ouest et le Chouf, en comprenant leur structure et leurs pratiques de gestion, discuter de leurs différents défis et souligner l'importance de mettre en place une typologie de système agricole pour faciliter la planification de l'élaboration de projets et de politiques.

iii. Données secondaires de courts métrages sur les socio-écosystèmes des parcours : Le réseau LIFLOD (Livestock Farming System and Local Development), coordonné par l'Université fédérale de Santa Maria (UFSM) à Rio Grande do Sul Brésil, a développé un projet de recherche axé sur la perception de la valeur des parcours par les communautés qui y vivent. La recherche est basée sur des

courts métrages animés par des communautés de parcours contrastés afin de présenter à d'autres communautés leurs biomes respectifs, leur vie d'éleveurs, leurs troupeaux et leurs pâturages, les principaux sujets de débat et de conflits dans leurs régions, et leurs scénarios pour l'avenir. Les courts métrages sont disponibles sur Youtube, et leur format général (lignes directrices) a été décidé lors d'un atelier d'une semaine tenu à Montpellier en Mai 2016 avec la participation d'une trentaine de jeunes et quelques chercheurs et acteurs compétents venant de parcours contrastés situés dans une dizaine de pays d'élevage sur les cinq continents. Après l'atelier de Montpellier, sept courts métrages, d'environ 15 à 20 minutes chacun, ont été produits dans les zones de parcours suivantes : les montagnes dans le nord-est du plateau tibétain, en Chine; la Serra Gaucha, Rio Grande do Sul, Brésil; la Pampa uruguayenne; les zones spéciales dans les grandes plaines, en Alberta, dans l'ouest du Canada; la zone bédouine de la zone de la côte nord-ouest en Égypte; les montagnes méditerranéennes du sud de la France; et le Ferlo dans le biome sahélien du nord du Sénégal.

Différentes méthodologies ont été utilisées pour analyser les données collectées:

i. Perception du changement des éleveurs de petits ruminants dans la Beqaa Ouest
ii. Typologie des systèmes d'élevage des petits ruminants dans la Beqaa Ouest
iii. Analyse de la filière du kishk dans la Beqaa Ouest et le Chouf
iv. Typologie des systèmes de production laitière familiale dans la Beqaa Ouest et le Chouf
v. Analyse de contenu vidéo : L'utilisation de films comme données secondaires dans la recherche gagne en popularité, en particulier parce que des technologies simples telles que les téléphones intelligents et les logiciels informatiques pour l'édition sont mises à la disposition de tous et sont également faciles à utiliser. Les films et les vidéos sont utilisés dans la recherche qualitative soit comme outils de collecte de données, soit comme sources d'information et de dialogue entre les chercheurs et les participants, mais aussi comme mécanismes de diffusion des résultats de la recherche (Given, 2008).

RESULTATS

Chapitre 3 : **Perception des fermiers vis-à-vis du changement et des stratégies d'adaptation des systèmes de petits ruminants dans la Béqaa Ouest au Liban** (Chedid, M., Tourrand, J.F., Jaber, L.S. and Hamadeh, S.K., 2018. Farmers' perception to change

and adaptation strategies of small ruminant systems in the West Bekaa of Lebanon. Small Rum Res 167: 16-21).

La question des changements est également étudiée dans le Chapitre 3, mais cette fois à travers la perception des agriculteurs du changement. Les agriculteurs de la Béqaa Ouest ont été interrogés sur la façon dont ils perçoivent les changements qui affectent leurs systèmes de production, mais également sur leurs stratégies d'adaptation. Comme expliqué précédemment, il est essentiel de comprendre le point de vue des agriculteurs et des bergers sur les changements auxquels ils sont confrontés, ainsi que de comprendre les stratégies d'adaptation qu'ils développent; cela faciliterait par conséquent le soutien de ces stratégies par le biais de politiques et d'actions locales adéquates, au lieu de la mise en œuvre de stratégies ou de politiques descendantes qui ne soutiennent pas les agriculteurs et les bergers mais compliquent plutôt leur processus d'adaptation.

Les résultats obtenus dans ce troisième chapitre, montrent quatre systèmes semi-sédentaires qui ont été identifiés : i) avec des bergers sans terre, de petits troupeaux et un accès aux résidus de cultures, ii) avec des petits troupeaux et aucun accès aux résidus de cultures, iii) avec des troupeaux de taille moyenne et un accès aux résidus de cultures et iv) avec de grands troupeaux. Les agriculteurs de tous les systèmes ont estimé que les contraintes de production étaient liées à l'accès et à la qualité des pâturages (25% des réponses signalées) et à la variabilité du climat (22,5% des réponses rapportées). Les incertitudes politiques et celles du marché (24,5% des réponses rapportées), les conditions socio-économiques à la ferme et la santé animale ont également été rapportés comme des défis de production. Les systèmes comportant de plus grands troupeaux étaient davantage affectés par les fluctuations des prix du marché et du coût de la main-d'œuvre que les systèmes comportant de petits troupeaux. En l'absence de soutien gouvernemental, les agriculteurs de tous les systèmes ont mis au point des stratégies d'adaptation à court terme qui impliquaient principalement plus de temps consacré aux pâturages (88% des agriculteurs), davantage de compléments alimentaires (67% des agriculteurs ont complété en moyenne 1 kg d'orge/ animal / jour) et une diminution de la taille du troupeau (61% des agriculteurs). Le changement de la mobilité du troupeau était également pratiqué mais dans une moindre mesure en raison de l'accès limité aux pâturages et aux politiques locales. Les systèmes de petits ruminants dans la Béqaa Ouest deviennent de plus en plus sédentaires face aux pressions environnementales et aux incertitudes du marché perçues par les fermiers, tout en diversifiant leurs stratégies d'adaptation.

Chapitre 4 : **Le Kishk libanais : un produit laitier traditionnel dans un système alimentaire local en mutation** (Chedid, M., Tawk, S.T., Chalak, A., Karam, S. and Hamadeh, S.K., 2018. The Lebanese Kishk: a traditional dairy product in a changing local food system. Journal of Food Research 7(5): 16-23. https://doi.org/10.5539/jfr.v7n5p16)

La durabilité des systèmes agro-pastoraux, qui est au cœur de ce projet de recherche, est étudiée non seulement au niveau de l'effet du changement global et de la perception des agriculteurs, mais aussi au niveau de la filière d'un produit pastoral appelé « kishk ». Le Chapitre 4 examine le rôle que ce produit laitier traditionnel joue dans les moyens de subsistance ruraux, les communautés agro-pastorales en particulier, et comment sa production a été maintenue sous la pression des forces du changement qui ont eu un impact sur ses deux principaux ingrédients : le blé et le lait de chèvre.

Les résultats obtenus dans ce chapitre montrent que la production du kishk avait été soutenue par les femmes rurales dans les zones désignées et n'était pas affectée par les changements survenus dans le secteur du blé, notamment l'introduction de nouvelles variétés de blé; au contraire, ce produit traditionnel a adopté les nouvelles variétés. En outre, la polyvalence de la recette du kishk préparée à partir de lait de vache, de brebis ou de chèvre rend ce produit laitier résistant aux changements de disponibilité et de source de lait. Cependant, la conservation du kishk traditionnel nécessite des efforts considérables en matière de marketing, de certification et de contrôle de qualité.

Chapitre 5 : **L'intensification comme un ensemble de scénarios possibles pour l'avenir de l'agropastoralisme: étude de cas des systèmes laitiers dans la Bekaa Ouest et le Chouf du Liban**

La question liée à la durabilité des systèmes agro-pastoraux est également abordée dans le Chapitre 5 à travers une étude de cas des systèmes laitiers dans les régions de la Beqaa Ouest et du Chouf. Ce chapitre examine le potentiel d'intensification en tant que stratégie adaptative pour certains systèmes de petits ruminants. Les systèmes laitiers sont présentés comme un modèle d'intensification pour l'avenir de l'agro-pastoralisme, en particulier pour les agneaux d'engraissement et les brebis de réforme, l'amélioration de la reproduction et des indices de croissance, la transformation laitière et la commercialisation.

Une typologie des systèmes de production a permis d'identifier cinq types de systèmes de production laitière en fonction de leur taille et de leur niveau d'intensification: 1) les grands exploitants ayant une activité laitière, 2) les systèmes laitiers intensifs avec des troupeaux de taille moyenne et de petites exploitations agricoles, 3) les systèmes laitiers intensifs de petite taille, 4) les petits agriculteurs avec un troupeau de taille moyenne et 5) les systèmes de subsistance avec de petits troupeaux de faible production laitière.

Les résultats montrent que la durabilité de ces systèmes dépend de plusieurs facteurs, notamment les coûts de production élevés, la variabilité climatique qui affecte la production et la qualité des fourrages, le rôle limité du secteur public dans la subvention de la filière du lait, et surtout les normes d'hygiène faibles à la ferme et lors de la manipulation du lait. La diversification des activités au sein des systèmes agro-pastoraux en plus de l'utilisation de technologies adéquates et adaptées, de la production de

fourrage et d'aliments concentrés, de races exotiques hautement productives et du développement des marchés pourrait être des enseignements à tirer du secteur laitier pour l'intensification de l'agropastoralisme. Cependant, l'application de certains de ces processus nécessite soit des investissements importants, soit l'acquisition de terres que la plupart les agro-pasteurs ne peuvent pas se permettre, limitant ainsi l'intensification à ceux qui disposent de ressources suffisantes pour l'adopter.

DISCUSSION

Chapitre 6 : Gestion des défis liés aux parcours : croisement des discussions et des points de vue des agro-pastoraux dans des zones contrastées (Ce chapitre représente une version plus élaborée du chapitre «Rangeland Challenges Management: Crossing Breeders' Talks and Points of View in Contrasted Areas » [Gestion des défis des parcours: traverser les pourparlers et les points de vue des éleveurs dans les zones contrastées], qui a été accepté pour publication dans le livre de l'UNESCO intitulé «Specific Environments Global Integrated Management» édité par Luiz Osterbeek).

Enfin, afin de confirmer (ou non) la deuxième partie de l'hypothèse relative aux stratégies d'adaptation des agriculteurs qui sont affectées par le contexte local des agriculteurs, une comparaison est faite entre l'étude de cas Libanaise et sept pays disséminés à travers le monde : Chine, Canada, Égypte, Sénégal, Uruguay, Brésil et France. Cette comparaison qui prend notamment en considération la perception des agriculteurs des lacunes et des défis liés aux pâturages et à la gestion des parcours dans des régions contrastées du monde, constitue le Chapitre 6 et répond à la quatrième question de recherche. L'analyse comparative effectuée montre que les lacunes et les problèmes signalés dans les sept films sont comparables à ceux identifiés dans l'étude de cas libanaise, en particulier en ce qui concerne la nécessité de politiques spécifiques qui régulent les socio-écosystèmes de parcours et valorisent leur diversité et leurs services essentiels.

CONCLUSION

Les systèmes agro-pastoraux du monde entier sont confrontés à des défis similaires, notamment la variabilité climatique et l'insuffisance ou l'absence de politiques de parcours ; par conséquent, ces systèmes développent des stratégies d'adaptation comparables telles que la complémentation des troupeaux en aliment, la diversification des activités agricoles, la réduction de la taille globale du troupeau et la limitation de la mobilité des troupeaux. L'étude comparative entre plusieurs écosystèmes de parcours, dont le Liban, a montré que la mise en œuvre de politiques locales réglementant l'utilisation des parcours et soutenant les systèmes agro-pastoraux contribue à accroître la durabilité de ces systèmes ainsi que ceux des parcours. Les agro-pastoraux du monde entier partagent la même perception du changement et des défis, et leur contribution à la planification des politiques et des projets de développement est très précieuse pour

l'efficacité de ces politiques et projets. De plus, les systèmes intensifs de bovins laitiers peuvent servir de modèle d'intensification pour l'avenir de certains agro-pastoraux, en particulier pour les agneaux d'engraissement et les brebis de réforme, améliorant la reproduction et les indices de croissance, développant le lait des petits ruminants et la transformation laitière. L'intensification peut être considérée comme un processus d'adaptation pour certains petits éleveurs de ruminants aux défis et aux lacunes auxquels ils sont confrontés, en particulier en l'absence de politiques réglementant l'utilisation des terres et soutenant les agro-pastoraux. Cependant, ce processus d'intensification mérite des recherches supplémentaires pour évaluer son impact sur l'identité de l'agro-pastoralisme traditionnel. Nous confirmons que l'étude de cas Libanaise est comparable à d'autres écosystèmes de parcours dans le monde et que le renforcement de politiques adéquates pour les parcours et les pâturages qui protègent également les écosystèmes naturels est critique pour la résilience des systèmes agro-pastoraux face aux changements mondiaux ainsi que pour renforcer la sécurité alimentaire.

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INTRODUCTION

Global change is a complex process encompassing environmental, climatic, social, economic, cultural and political changes. It is a set of different interconnected factors that can be seen as either causes or consequences (Last, 1993). These "meta-factors" of change include numerous factors such as growing populations, increasing migration, new social demands, industrial development, structural deficit in food security, climate change and climate variability, environmental pollution and degradation, depletion of natural resources, political transformation, regional development, development and implementation of new technologies, and financial instability etc. (Haan et al., 2002 ; McMicheal, 2013; Daoud et al., 2016; Dong et al., 2016). Subsequently, concerns are raised on how to produce enough food to meet the global food demand of a fast growing human population while preserving natural resources and under the pressure of global change (Haan et al., 2002).

Global change has always caused great pressure on pastoralism around the world and its undesirable impact will keep adding stress on pastoral systems (Dong et al., 2016). Specific factors of change compromising the sustainability of pastoral systems have been identified in Lebanon and described in the first chapter; these are i) Lack of policies and laws related to pastoralism and land tenure; ii) Urbanization and rural migration; iii) Encroachment by agriculture; iv) Deforestation and overgrazing; v) Lack of technical skills and data for range management; and vi) Climate variability. The weight of these factors (and probably others) on pastoral systems is translated into a decline in rangeland resources in terms of mainly water and feed, nutrient shortage due to conversion of pasture lands, a shift to more sedentary systems, changes in social practices, a decline in number of animals and herds and even abandon of farming activities (Ben Salem and Smith, 2008; Dick et al., 2008; Daoud et al., 2016; Chedid et al., 2018).

Nonetheless, pastoral systems known for their high resilience, have developed adaptive mechanisms (Hamadeh et al., 1999; Kratli et al., 2013) which when coupled with adequate local policies enable those systems to overcome challenges and hence sustain the livelihoods of their communities (Daoud et al., 2016). These mechanisms have been broadly documented worldwide and include among others diversification of income generating on-farm and off-farm activities, reduction of overall herd size, restricted mobility, feed supplementation etc. (Hamadeh et al., 1999; Ben Salem and Smith, 2008; Dick et al., 2008; Alary et al, 2016).

To reduce the vulnerability of pastoral systems and increase their resilience to global change, the responses of pastoral systems and their adaptive mechanisms to stressors should be analyzed and understood (Dong et al., 2016). The inclusion of farmers in policy making and program planning is also imperative for successful development plans and hence should be taken into consideration.

Based on the above, and our speculation that *agro-pastoralists in contrasted areas of the world face similar challenges and share same concerns but their adaptive strategies are affected by their local context which either enhances or weakens their sustainability*, the objective of this research is to assess the sustainability of agro-pastoral systems in Lebanon which are undergoing global changes. Accordingly, the key research questions fall under four broad headings:

1. What are the global changes that are affecting the sustainability of agro-pastoral systems in Lebanon?
2. How do farmers perceive these changes and what are the adaptive strategies they develop in response to these challenges?
3. How is the sustainability of small ruminant systems reflected by the value chain of the traditional cheese “kishk” typically prepared with goat milk?
4. Is the Lebanese case comparable to other contexts around the world?

Before moving to the first chapter it is essential to explain the linkages between the four research questions and their relevance to the hypothesis.

The first research question serves as a start point to identify the global changes that are affecting the sustainability of agro-pastoral systems in Lebanon. To answer this question, a thorough review of literature, including reports, scientific publications and other relevant documents, was conducted. Results are reported in Chapter one.

The question on changes is also investigated in Chapter three, but through the farmers’ perception of change this time. Farmers in the West Bekaa were interviewed about how they perceive changes that affect their production systems, but also about their adaptive strategies. As previously explained, it is vital to understand the point of view of the farmers and shepherds on the changes they are facing, as well as understand the coping strategies they are developing; this would consequently facilitate the support of these strategies through adequate local policies and actions instead of the implementation of top-down strategies or policies that do not support the farmers and shepherds but rather complicate their adaptation process.

The sustainability of agro-pastoral systems, which is at the core of this research project, is studied not only at the level of the effect of global change and farmers’

perception, but also at the level of the value chain of a typical agro-pastoral product called “kishk”. Chapter four looks at the role this traditional dairy product plays in rural livelihoods, agro-pastoral communities more particularly, and how its production has been sustained under the pressure of forces of change which have impacted its two main ingredients: wheat and goat milk.

The question related to sustainability of agro-pastoral systems is also addressed in Chapter five through a cse-study of the dairy systems in the West Bekaa and Chouf regions. This chapter discusses the potential of intensification as an adaptive strategy for some small ruminant systems. The dairy systems are presented as an intensification model for the future of agro-pastoralism especially for fattening lambs and culled ewes, improving reproduction and growing indices, dairy processing and marketing.

At last, in order to confirm (or not) the second part of the hypothesis related to the farmers’ adaptive strategies that are affected by the local context of farmers, a comparison is made between the Lebanese case-study and seven countries scattered around the globe. This comparison which namely takes into consideration the perception of farmers to gaps and challenges related to pastures and rangeland management in contrasted areas of the world constitutes Chapter six and answers the fourth research question.

Answering these questions will validate or not our hypothesis, and obtained results are expected to offer a helpful tool to the concerned development stakeholders (ministries and development agencies) to define the means of intervention to increase the sustainability of the traditional agro-pastoralism which is breaking down under the effect of global change. It has been shown that planning and risk reduction efforts are not enough to help agro-pastoralists deal with external threats, but it would be more efficient to enable and reinforce their innate adaptive capacity and help them to be more autonomous rather than providing adaptation strategies for them.

Finally, I would like to stress on the methodology used in this project and which differs from the traditional approaches used to assess sustainability. This methodology can be proposed as an innovative research framework to assess sustainability and includes different methods such as i) System analysis, ii) Perception, iii) Value-chain analysis and iv) Analysis of short videos combined together to serve the aim of this research project.

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CHAPTER I: CHALLENGES FACING AGRO-PASTORAL SYSTEMS IN THE DRY ARAB REGION: A CASE STUDY FROM LEBANON

This chapter serves as a starting point of the research project. It describes the changes that have occurred to the agro-pastoral system in a semi-arid region of Lebanon while identifying the gaps and challenges facing the system and which can be scaled-up to the national level. Technical solutions are proposed at the end, which can contribute to increasing the socio-economic efficiency of the sector while enhancing its sustainability.

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Défis des systèmes agro-pastoraux dans la région Arabe aride : une étude de cas du Liban

Résumé

Le pastoralisme était un mode de vie traditionnel très répandu dans les pays arabes, en particulier dans les zones rurales. L'élevage reste un contributeur majeur aux moyens de subsistance de ces communautés bien que de nombreux facteurs limitent la productivité et la croissance du secteur. Les prairies et les pâturages sont soumis à des pressions en raison de politiques biaisées en matière d'accès aux terres, d'empiétement agricole, d'urbanisation, de surpâturage et de rudes conditions climatiques. Des études sur le secteur des petits ruminants dans la vallée de la Békaa au Liban ont montré d'importants changements adaptatifs dans les systèmes de production au fil du temps, notamment : la diversification des revenus par le biais d'activités non agricoles, la réduction de la taille du troupeau et une transhumance limitée. Un abandon complet de la production animale a également été observé et certains agriculteurs ayant opté pour une source de vie totalement différente. Les défis auxquels sont confrontés les systèmes d'élevage pastoral restent largement ignorés, bien que la demande de produits animaux augmente régulièrement, en raison de la croissance démographique et de la richesse accrue. Des politiques favorisant l'accès aux pâturages et à la réhabilitation des parcours sont absolument nécessaires, en plus des services financiers, vétérinaires et techniques.

Mots-clés: systèmes agro-pastoraux, défis, Liban

Challenges facing agro-pastoral systems in the dry Arab region: a case study from Lebanon

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Abstract:

Pastoralism was a widespread traditional way of life in the Arab countries, especially in the rural areas. Livestock remains a major contributor to the livelihoods of these communities although many factors are limiting the productivity and growth of the sector. Pastures and rangelands are put under pressure due to biased policies in relation to land access, agricultural encroachment, urbanization, overgrazing and harsh climatic conditions. Studies on the small ruminant sector in the Bekaa valley of Lebanon showed important adaptive changes in production systems over time including: income diversification through off-farm activities, reduction in herd size and limited transhumance. A complete shift away from livestock production was also noticed with some farmers opting for a totally different source of living. The challenges that the pastoral livestock systems are going through remain largely ignored although there is a steady increase in demand for animal products driven by the population growth and increased wealth. Policies supporting access to grazing land and rangeland rehabilitation are highly needed in addition to financial, veterinary and technical services.

Keywords: agro-pastoral systems, challenges, Lebanon

1. INTRODUCTION

Livestock sector in the Arab countries

Livestock production in the Arab countries has always contributed to the livelihoods of rural communities, especially in the arid regions where livestock allow the conversion of the scarce feed into nutritionally and economically valuable products. Pastoral and agro-pastoral activities ensure about 60% of the income of poor Arab rural families who partially depend on livestock to sustain their living (Hamadeh et al., 2015); and the whole family is usually involved in the farm labor.

Animal breeds and species raised in the Arab countries are usually of small size and highly adapted to arid environmental conditions; these would include 38 breeds of sheep, indigenous Awassi being the most productive and popular, 54 breeds of goat, and 38 breeds of camel. Other species raised in the area comprise 22 breeds of cattle, 9 breeds of horses, and 3 breeds of buffalo (AFED, 2011). Despite this richness in animal genetic resources, the productivity of meat and milk in the Arabic countries is considered to be low due to many reasons such as the absence of significant genetic improvement programs, poor production systems, and the mismanagement of natural resources particularly water and rangelands (AFED, 2011).

Livestock production in the Arab countries is limited by the distribution of production systems: up to 90% of the range-lands fall under arid or semi-arid regions such as semi-deserts in the Arabian Peninsula and the semi-arid steppe or Badia in Syria (FAO, 2012). The traditional agro-pastoral system relies on natural pastures and animal mobility in order to respond to changes in water and feed resources, diseases, droughts and other environmental adversities. However, this system has been facing increasing pressures in the past decades varying from land degradation, increased population, and absence of range-land management policies etc.

Feed constitutes the major cost of livestock operations, especially in the Arab countries where local feed production is limited and costly. Given the scarcity of arable lands in most of these countries, there's a challenging choice to be made between using the land for human food production or for animal feed. Feed production in the region is mostly rain-fed with low productivity. Attempts to increase local feed production through irrigation have resulted in heavy drainage of the non-renewable water resources thus prompting the termination of such programs in countries were the water reserves have been depleted, such as the case in Saudi Arabia (USDA, 2013).

The population in the Arab countries is expected to maintain a rising growth rate, becoming increasingly urban and consuming more animal products. Hence, in order to meet the growing demand on animal products, increasing livestock production will be challenging. According to the report on climate change in the Middle East published by Brown and Crawford (2009), climate models are predicting a hotter, drier and less predictable climate. These changes will have a series of consequences in the region, especially on agriculture. Elasha (2010) describes the projected effects of global warming on the Arab countries: Temperatures could increase by 4oC in some countries with a decrease in rainfall of more than 30%, thus making the area threatened by desiccation. Naturally this will affect the agricultural yields which are expected to decrease by 21%, with a decrease in value of as much as 40% in some Arab countries.

Agricultural policies in the Arab region up until 1997 were generally centred on self-sufficiency and characterized by lack of coordination and integration within a unified Arab framework, leading to weak trade and poor inter-Arab agricultural investments. These arbitrary policies affected the livestock sector which was also put under the pressure of increasing demand for animal products linked to the rapid growth in wealth and population numbers. Consequently, Arab countries introduced policies to increase production to meet the rising demand and to alleviate the effect of sporadic drought and disease on the most vulnerable producers. These policies took into account feed and animal subsidies, pasture restoration and access to grazing lands in Syria, and improved veterinary services and financial assistance for the acquisition of modern technologies and investment in infrastructure like in Syria and Morocco (AOAD 2008). However, these policies failed to achieve the desired objective and led to an imbalance

between resources – especially feed- and livestock populations and consequently a high dependence on government subsidies which aggravated the vulnerability of the rural livestock farmers to poverty and food insecurity and has created an economically and socially delicate balance with constant threat of strife over water and land resources within and across countries.

2. CASE STUDY: BEKAA VALLEY - LEBANON

Pastoralism constitutes an important part of the Lebanese patrimonial heritage especially of the rural communities mainly by maintaining close social relations between the different generations and sustaining the livelihoods of these societies. Small ruminant keepers in Lebanon are shepherds living in marginal areas, and for whom milk and meat products constitute a major source of living. While goats and sheep production rely on pastures, cattle and pigs (found in lesser numbers) are mainly raised in farms. FAO (2015) estimates that almost 60 percent of livestock farmers in Lebanon depend on dairy animals as their main source of income. The adopted farming system is the extensive and traditional pastoral system, centuries-old, conducted on natural pastures by roaming shepherds. Herds are in transhumance between the highlands and coastal zones to ensure the feed during the different seasons of the year. According to a survey conducted by Hamadeh et al. (2007), there is a rising trend nowadays, in the entire Bekaa area, towards a pastoral system based on “rented labor” enabling the owners of the small herds to practice other activities or jobs. This is one major factor threatening the social aspect of pastoralism in Lebanon, and leading to the extinction of the various forms of traditional sharing.

2.1. National herd numbers

According to official figures (MoA 2005, 2007 and2010), the Lebanese small ruminants herd witnessed fluctuations in its numbers; an accentuated drop was noted in 2006 after the Israeli attack on Lebanon, figures increased in 2007 to significantly decrease again in 2010. Following the Syrian crisis in 2010, numbers rose once more due to the cross-border animal movement (estimated to 60%). Refugees who have fled Syria brought with them large numbers of unvaccinated animals putting at risk the health of 70,000 (local) cows and around 900,000 (local) sheep and goats (FAO, 2015). Other reasons that contributed to the increase in livestock population is the support of international development agencies which provided vaccines, drugs, veterinary services and feed to around 900 small-scale livestock farmers (mainly in North Lebanon) thus encouraging them to buy more animals (UNDP, 2014).

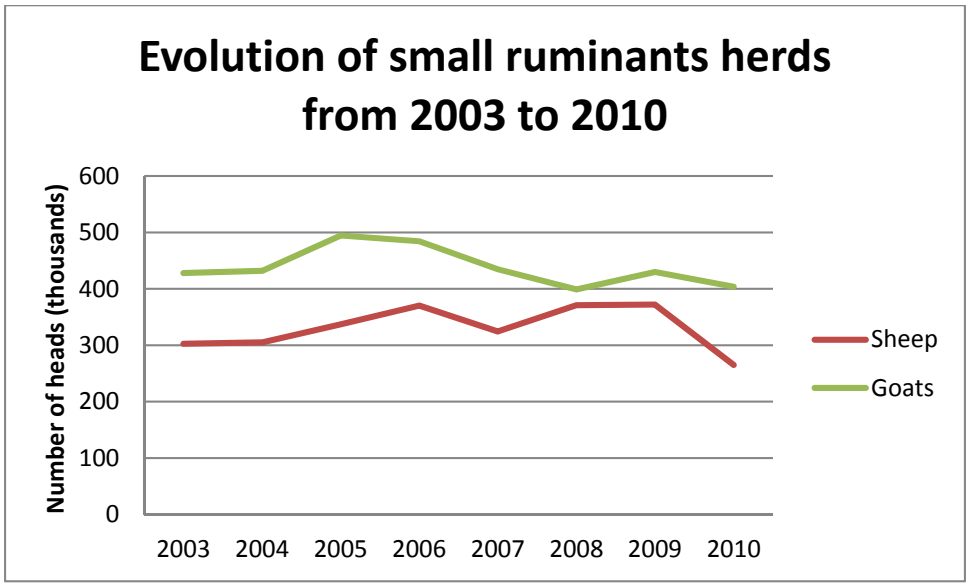

Figure 1: Evolution of small ruminants herds from 2003 to 2010 (thousands of heads). Source: Compiled from MoA (2005, 2007, 2010)

2.2. Main pastures and distribution

Permanent pastures are almost absent in Lebanon, they cover only 16,000 ha which is about 15% of the country's surface. Seasonal grasslands are unevenly distributed and are located mainly on mountain tops and in the Bekaa northern prairies (Gintzburger et al., 2006); they heavily depend on precipitation, rainfall distribution and temperature. Hence, shepherds mostly rely on woodlands and forests to feed their animals, and depend less on crop residues and feed supplement (Asmar, 2011). However, the changing weather accompanied by decreased precipitation and rising temperatures will make it harder to find grazing pastures, and shepherds will tend to rely more on feed supplements and feed blocks which could jeopardize the resilience of these production systems to climate change, since feed is constantly offered to animals irrespective to the availability of pastures (Enne et al., 2004).

Rangelands cover 50% of Akkar lands and constitute the major pastures of the North. According to Srour (2006), the large herds in North of Lebanon are in semi-nomadic systems depending more on meat production as their main source of income, whereas the intensified small-ruminant production systems have milk production as their major source of living. In Mount Lebanon, the terraced hills are the home for small-ruminants production in this area. The borders of the Shouf Cedar Biosphere Reserve (SCBR) include two major grazing sites (Abi-Said, 2004) and the southern prolongation of the Mount Lebanon and Anti-Lebanon mountain chains constitutes the major pastures of South Lebanon including the Caza of Nabatieh. This part of the mountain is characterized by dry hills and still contains nowadays mines from the Israeli occupation which presents serious danger to the shepherds and their herds (Institut de

l'Elevage, 2003). Finally, the Bekaa valley and its surrounding mountains account for 40% of the country's grazing lands of which 30-40% consist of common lands and insures 20-30% of the animals' diet (Hamadeh, 2002).

2.3. The Bekaa: center of small-ruminants production

The Bekaa valley has the largest small ruminant concentration accounting for approximately 50% and 74% of the total caprine and ovine national herd respectively (MoA/FAO, 2009). The northern part of the Bekaa characterized by a semi-arid climate includes the main pastoral communities of Arsal and Hermel who own the largest flocks. However, 65% of Arsal shepherds are landless (Srour, 2006) and heavily depends on ranges to secure more than 45% of their animals feed (Hamadeh et al., 1995); the shepherds of Hermel also highly rely on transhumance and their grazing routes would reach 200-300 km (Srour, 2006). The absence of permanent pastures has pushed the pastoralists to feed their herds on forests resources, especially after the agricultural reform in Syria which restricted the grazing lands in the neighboring country (Hamadeh et al., 1993).

The Bekaa valley covers about one third of the Lebanese territory and receives precipitations of 230 mm and 610 mm in its Northern and Central parts respectively. In this area, small ruminants systems mainly rely on pastures and rangelands during spring and summer but also on crop residues as a source of feed (Srour, 2006).

The indigenous breeds of Awassi sheep and baladi goats are highly adapted to semi-arid environments and are recognized for their ability to withstand high ambient temperatures and tolerate water deprivation (Jaber et al., 2004). The most common systems in goat keeping are sedentary with vertical transhumance, whereas semi-nomadism and horizontal transhumance are usually adopted in sheep herds. This difference is due to the capability of the goat to reach the most marginal and difficult areas that no other ruminants can value, probably making this animal easier and cheaper to raise.

Home to nearly half of the national small-ruminants herd, the Bekaa is the focal point of most studies conducted in order to understand the pastoral systems in Lebanon, their types and livelihood strategies. Several research and development projects conducted by the American University of Beirut (AUB) considered Arsal– a marginal village of 36,000 ha on the Western slopes of the Anti-Lebanon Mountains – as a case study since the Arsali shepherds own the largest population of small ruminants (around 60,000 heads of sheep and goats according to Dick, 2003). The fact that this region is more prone to climate variability impact, attracted researchers and students to investigate and identify the strategies of adaptation of small-ruminant systems to climate constraints.

A farming system analysis of Arsal (Hamadeh et al., 1999) revealed the existence of 6 systems of which 2 had minimal small ruminant activities and depended either on off-farm activities supplemented by fruits and cereal production to secure their income, or ensured their livelihoods exclusively from off-farm activities (Table 1).

Table 1: Arsal farming systems

#	**System activities**	**Main activities contributing to income**
1	Fruit and cereal production with minimal small ruminant activities	Off-farm activities supplemented with fruit production
2	Small scale cereal and fruit production with minimal small ruminant activities	Off-farm activities exclusively (90%)
3	Medium scale cereal and fruits	Fruit production
4	Cereal, fruit and medium-sized flocks	Animal production (80%) supplemented with off-farm activities and cereals
5	Big flocks and small crop production	Animal production (90%)
6	Fruit production on a large scale	Fruit production

Source: Hamadeh et al., 1999

The obtained results show that although newly established, fruit production started to considerably contribute to the income of these societies. Facing environmental constraints and property right conflicts, herders modified their livelihood strategies and sought income diversification. Their new adopted strategies relied more on pasture grazing, reducing quantities of feed and herd size, and minimizing the movement of the flocks (Dick, 2003). It was clearly shown that the farming systems in Arsal were shifting towards a more sedentary system with rainfed fruits production away from traditional agricultural crops such as cereals (Hamadeh et al., 1999).

A deeper investigation into the small-ruminant systems of the area identified 4 systems (Hamadeh el al., 91999): a semi-nomadic system moving seasonally seeking native pastures, a semi-sedentary system with herds grazing on the mountain pastures in spring and summer, a semi-sedentary feeding on crop residues in the summer and a sedentary system relying on the common rangelands and the pastures of the village. A comparative study of the Arsali farming systems between 1997 and 2002 showed a decrease in flock numbers and an increasing stocking rate in the pastures with a maintained sheep to goat ratio enabling the herds to use the pastures more effectively (Dick, 2003). Furthermore, in 2002, the sedentary or settled system did not exist anymore; farmers sold their entire flocks and shifted to other activities in order to sustain their living.

Similar herd management strategies were recently observed in West Bekaa (Chedid, unpublished); facing climate variability (mainly decreased precipitation) and an

unsettled political situation, shepherds in the West Bekaa decreased their flock numbers, and limited their mobility to their villages' surrounding on rented pastures (winter spent in the mountain forests and summer on crop-residues in the plain). However, to cope with limited pastures productivity and maintain a stable milk production, they resorted to supplementing their animals with feed.

2.4. Gaps and challenges facing pastoral systems

The different challenges facing pastoralism that were observed in the Bekaa case studies can be scaled-up to the national level. These are summarized as follow:

i. Lack of policies and laws related to pastoralism and land tenure

Land tenure and the form of ownership significantly affect the opportunities to exploit natural resources and to decide where and how to expand the land (Zurayk et al., 2001; Enne et al., 200). This is why farmers, who have access to only marginal lands, or who temporarily or illegally use the land, will practice activities disregarding the risks of land degradation (Zurayk et al., 2001).

In Lebanon, national policies on land use and land tenure relevant to pastures management and preservation are either very old (outdated) or do not exist at all. As most of the shepherds do not own the land they graze, they resort to lease and use public and/or private forest areas and rangelands and crop residues to feed their animals (Hosri and Nehme, 2006; Asmar, 2011) which, added to the feed supplement expenses, represent a big limitation to the profitability and hence the sustainability of these systems (Hamadeh et al., 2001). The main problems of land ownership in Lebanon are related to land tenure insecurity especially for poor people and farmers, the unclear overlapping land rights caused by legal ambiguity or practices, the land encroachment and illegal settlers that farmers cannot prevent in the absence of legal protection, and finally the absence of land survey either by municipalities or local authorities (Hamadeh et al., 2005). All these reasons, complemented with the lack of regulations, have weakened the traditional institutions and the system of communal range management in maintaining common lands.

ii. Urbanization and rural migration

The increasing population combined with a decrease of land and resources is a major challenge to pastoralism worldwide, and pastoral systems are mainly susceptible to the increasing demography because of the lack in techniques that sustainably augment the productivity of the pastures (Nori et al., 2008). The increased population especially at the expense of pastures obstructs the flexibility of animal movement, leading to the concentration of animal stock on the same lands and consequently causing overuse of these lands. The imbalance in animal distribution in Lebanon has led to overgrazing and deterioration of pastures in the areas with high animal density, and

to increased biomass production in the areas that lack herds, and subsequently to increased risks and occurrences of fires.

The rural population in Lebanon declined from 58.5% of the total population in 1960 (Abi Samra, 2010) to 26.3% in 1980 and then to 12.9% in 2010 and is expected to drop to 8.8% in 2050 (UN, 2011). This decrease is most probably linked to lack of diversification in rural economies and inadequate infrastructure and social services in marginal areas.

iii. Encroachment by agriculture

The conversion of marginal lands to agricultural activities is preventing their use as rangelands. The investments done in the marginal lands, such as planting rain-fed fruit trees, are not taking into consideration the long-term effect of these activities such as soil erosion which will decrease the quality and quantity of pastures and lead to animal loss eventually and a reduction of the pastoralists' income (Hamadeh, 2002). This is the case of Arsal, which used to be a traditional agro-pastoral area, and where the plantation of 1.5 million of cherry and apricot trees resulted in the fragmentation of the land and hence the loss of rangelands (Chahine, 1995). Shepherds were pushed to seek new pastures, and sometimes graze in the newly established orchard which resulted in conflicts between them and the orchard growers, and ended in an acute drop of the number of small ruminants – from 90,000 to 60,000 (Zurayk et al., 2001).

iv. Deforestation and overgrazing

Pastoralism is a balanced use of the dry lands enabling a productive livelihood in the roughest areas of the world (Nassef et al., 2009). Despite their environmental contribution, pastoralists have always been accused of being harmful to the environment: accusation of overgrazing and desertification, and more recently of methane emissions and even low feed conversion rates (*FAO, 2001*). Rangelands in Lebanon which constitute graze lands for agropastoral ruminant production are being overgrazed, and if unsustainable grazing persists, these lands will end up losing their biodiversity (*MoE, 2009*). The Lebanese ecosystems have always been subject to deforestation caused by fire, grazing and quarrying. Overgrazing threatens the regeneration of indigenous tree species such as juniper and inhibits the restoration of biodiversity (MOE/UNDP/ECODIT, 2011). Back in time, grazing in Lebanon used to be controlled by traditional grazing laws and rights taking into consideration the carrying capacity of the lands estimated to 1 head of sheep and goat per hectare (ha) on good rangelands, declining to 0.2 head/ha on marginal lands. According to studies, the stocking capacity is exceeding 20-30% on Mount Lebanon and Anti-Lebanon slopes; and in the Northern Bekaa, a carrying capacity of 10 heads/ha was documented: about 7 times more than the acceptable stocking rate (1.5 head/ha) (Hamadeh, 2002). This may be due to an increase in the pressure on the land, caused by the decline in pasture areas and the impoverishment of the rangelands. Concurrently, El-Awar et al. (2007) reported,

a decline of biomass production in the grazing systems of the semi-arid regions in Lebanon, when stocking rates augment from 0 to 4 sheep/ha. The same authors also concluded that a resting period is compulsory in order to sustain the production of the pasture while limiting nutrient loss.

"*Hima*" or "protected area" in Arabic is a traditional way to protect natural resources and managing them in a sustainable way. In order to protect the Lebanese forests, the Ministry of Environment designated many sites as national "*Hima*" and imposed laws banning grazing and other activities within a 500m radius. A successful story on controlling grazing in a natural reserve is the case of the establishment of Shouf Cedar Biosphere Reserve (SCBR) which limited grazing activities to a buffer zone that was created around the reserve and set rules regarding grazing time and stocking rate thus allowing vegetation replenishment and biodiversity preservation (Abi-Said, 2004).

v. Lack of Technical Skills and Data for Range Management

One main reason which prevents the pastoral system from improving is that herders have no access to updated knowledge and technical expertise. They also lack access to veterinary services and credit facilities which can help improve their production (Asmar, 2011). Despite the establishment of a rangeland management unit in the Ministry of Agriculture, the extension service related to rangeland management and pastoralism seems to be inefficient or simply missing (Hamadeh, 2002). National data on the status of pastures and their actual and potential carrying capacities and use do not exist; appropriate rangelands management strategies and mapping, as well as environmental data are also not available (MoE and UNDP, 2011; Hamadeh, 2002; Hosri and Nehme, 2006). Moreover, there is no serious interest to-date in studying rangelands in order to develop sustainable management policies. Studying grazing systems should take into account i) the dynamics of rangelands problems at the local and national levels, ii) the main factors behind the sustainability of traditional pastoral systems in Lebanon; iii) the role of the different stakeholders in the sector, iv) the indigenous knowledge around pastoralism and v) the encouragement and enhancement of the coordination between the public and private institutions in projects related to rangeland and pastoralism (Hamadeh, 2002).

vi. Climate Variability

Evidence shows that pastoralism can perform well under the prevailing context of climate variability in the presence of adequate policies, good investment and support (Nassef et al., 2009).

The weather forecast for the Middle East predicting changes in the distribution, quantity and frequency of precipitations will affect grazing periods and pastures' quality by changing the species composition in favor of woody and less palatable plants (MoE

and UNDP, 2011). As precipitation declines, finding pasture land for livestock will become harder. However, since climatic change will make it harder to grow cereals on the marginal lands in arid regions, only pastoralists will be able to conquer these areas as it seems to be the case in some countries of the Maghreb and Mashreq (Nori et al., 2008).

Until today, no effect of Climate variability on Lebanon's rangeland has been revealed in studies yet (MoE and UNDP, 2011); recent literature on the subject is still based on speculations and predictions.

2.5. Recommendations

Pastoralism is a lifestyle of subsistence embedded in an ecosystem in which the social, economic and political organization is complex. Policy makers are usually unaware of the constraints that pastoral communities face in order to sustain their livelihoods; hence these groups are marginalized and often not involved in decision-making regarding the development of efficient governmental programs for rangelands management.

Community-based rangeland management, in order to be successful, should not only assist rural communes in better managing their lands, pastures, animals and other resources, but also in promoting cross-community resource sharing and involving the community in decision-making through participatory approaches. Sustainable pasture management contributes to the preservation of the ecosystem and could be done by supporting indigenous knowledge and reviving old traditions, however, this cannot be done without adequate policies and a national strategy or action plan.

2.5.1. Technical solutions

i. Reduce the pressure on the pastures

Controlling herd size is a common practice in pastoral communities in order to adapt to emerging constraints or changes. Shepherds reduce the number of their animals when natural resources become scarce. However, enforcement limits on herd size according to pastures carrying capacities, complemented with capacity building on herd management and herd health are required to achieve a rational stocking rate and help reducing pressure on pastures while increasing productivity of the flock and allowing the re-growth of the grass.

ii. Improve the degraded pastures by reseeding with native legumes and grass

Reseeding grasslands with wild and native legume varieties was found to be an efficient way to "rehabilitate" pastures as long as it is complemented with a regulated grazing program (rotational grazing and respected carrying capacity). Sown forage decrease feed supplementation and help increasing the carrying capacity of the pasture as the quantity and quality of feed increase. In this context, native legumes should be collected, their seeds multiplied and used to regenerate degraded rangelands (Hamadeh, 2002). Moreover, inter-cropping legumes with fruit trees is a source of feed to animals, especially in dry months of the year (Darwish and Faour, 2008) and plays an important role in nitrogen fixation in the soil and water preservation. However, it is required to secure the production for these legumes, probably through government institution (Hamadeh, 2002).

iii. Plant fodder shrubs

Shrubs species that are resistant to drought, adapted to the local soil type and rich in biomass can be planted in order to compensate the deficit in pastures. These could include spineless species of cactus (*Opuntia ficus indica*) that were introduced to Tunisia and Egypt, and species of saltbush (*Atriplex nummularia* and *Atriplex halimus*) adapted to marginal lands (Hamadeh, 2002). The only constraint would be flock management in rehabilitated ranges and ensuring adequate nurseries and multiplication techniques (Nefzaoui et al., 2012).

iv. Establishment of pastoralists' cooperatives

One way to ensure that the concerns of pastoral communities are heard is that they organize themselves into cooperatives. The establishment of a shepherd cooperative in Arsal is a fine example: shepherds joined forces in order to improve the small ruminants' production in their region through facilitating technology and knowledge transfer between them and having better access to market. Under the cooperative, and with financial support from GTZ, the herders rehabilitated a pilot range in order to showcase how range preservation and rehabilitation can help combat desertification (Hamadeh et al., 2005).

2.5.2. Policy level

Land tenure is one of the main reasons leading to the breakdown of the traditional agro-pastoral system in Lebanon. Water right and access to water also play a crucial role in fragmenting this system, especially in the absence of regulations that control water distribution and use, and when the lands that are grazed by the shepherds are far from water sources. Nevertheless, local communities (shepherds and land owners), local authorities and NGO's should be involved in decision-making regarding rangeland management, and regulations should be complemented by capacity-building

for animal keepers on herd and resources management, animal health etc. (Hamadeh, 2002; Srour, 2006).

The National Action Plan (NAP) to Combat Desertification (MoA/NAP, 2003), laid the basic outlines for a national action program to promote sustainable management of grazing and rangelands and for empowerment of the sector such as establishing a comprehensive legislative and policy framework, developing a national rangeland strategy, supporting the development of a proper land tenure system, building the capacity of livestock holders on relevant subjects and through pilot models, and supporting the systems through research and studies, etc. However, none of this has been implemented to-date.

The reform of the grazing sector should start with an assessment of rangelands on the national level followed by a national strategy for the conservation and management of the pastures with the help of all stakeholders - responsible representatives of pastoral communities, rural land institutions, policy makers, etc. (Hamadeh et al., 2005). The extension service of the MoA should be strengthened and consequently the capacity of shepherds will be built through training and follow-ups. As also mentioned in the NAP, demonstrational plots on pasture rehabilitation should be implemented and should complement the technical training. Land legislation and policies relevant to rangelands management should be revisited and updated in a way to clearly specify responsibilities over its protection and grazing capacities and programing.

3. CONCLUSION

Meeting the demand of the constantly growing Arab population is a challenge for the Arab livestock sector. Unfavorable policies and harsh environment put high pressure on the prevalent nomadic and semi nomadic livestock systems leading to low animal productivity and rangeland degradation in the absence of support services and infrastructure. However, pastoralism remains a sustainable form of livestock production capable of filling a large part of the demand in spite of the scarce natural resources and climate variability. Proper public policies and supporting services are needed to maintain this production system and preserve the livelihood of a vast majority of rural Arab communities.

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CHAPTER II: MATERIAL AND METHODS

1. Introduction

In this chapter the study area (West Bekaa and Chouf) are described, and their selection for this study is justified. The framework of the used methodology is defined and the different methodologies for data collection and analysis are vindicated. The research approach was both quantitative and qualitative based on empirical data collected from surveys and case studies and secondary data gathered from reviewed literature, short movies and online data (trusted websites).

2. Study area

With a surface of only 10,452 km^2, Lebanon is one of the smallest countries of the Middle East and the Mediterranean region. However, this relatively small country, stretching over 225 Km of shoreline on the east of the Mediterranean Sea, is characterized by two mountain chains: the Mount-Lebanon with mid-height mountains of around 1000 m of altitude above sea level and high mountains rising up to 3087 m in the north of the country, and the Anti-Lebanon mountain chain on the Syrian borders, with tops reaching about 2800 m of altitude. The two mountain chains are parallel to the sea, separated from each other by the Bekaa valley on an average altitude of 900 m, and characterized by a semi-arid to continental climate with unpredictable rainfall and recurrent droughts.

Due to its geographical location, Lebanon's climate is typically Mediterranean, with heavy rains during winter (November to May) and dry months through the rest of the year. However, the country knows several eco-climatic zones depending on rainfall: the coastal strip including the northern, central and southern zones, the two zones (central and northern) of Mount-Lebanon and the Bekaa Valley with its northern, central and southern zones. The combination of different climatic zones in the country

with fertile soils and relatively abundant water, offers favorable conditions for the production of a wide range of crops.

Lebanon's economy is oriented mainly towards service provision including tourism, financial services and commerce which has been transmitted from the Phoenician ancestors who were the dominant traders in the Mediterranean Sea about 3000 thousand years ago (Zalloua et al., 2008). The agricultural sector is left to play relatively minor role in the country's economy hence contributing to only 5 % of GDP and securing jobs for 9% of the national labor force (MoA, 2014). Nevertheless, agriculture remains an important source for livelihoods in rural areas like the Bekaa, the south and north of Lebanon, contributing to the livelihoods of 25% of the rural labor force (MoA, 2014).

Although the majority of farmers in Lebanon are men, women constitute around 8.6% of the total farmers (MoA, 2012) and are involved mainly in processing activities such as dairy products, food preserves called "mouneh" in the local language, but also in subsistence farming activities.

Figure 2: Lebanon's location on the world map (Source: Google maps, 2019)

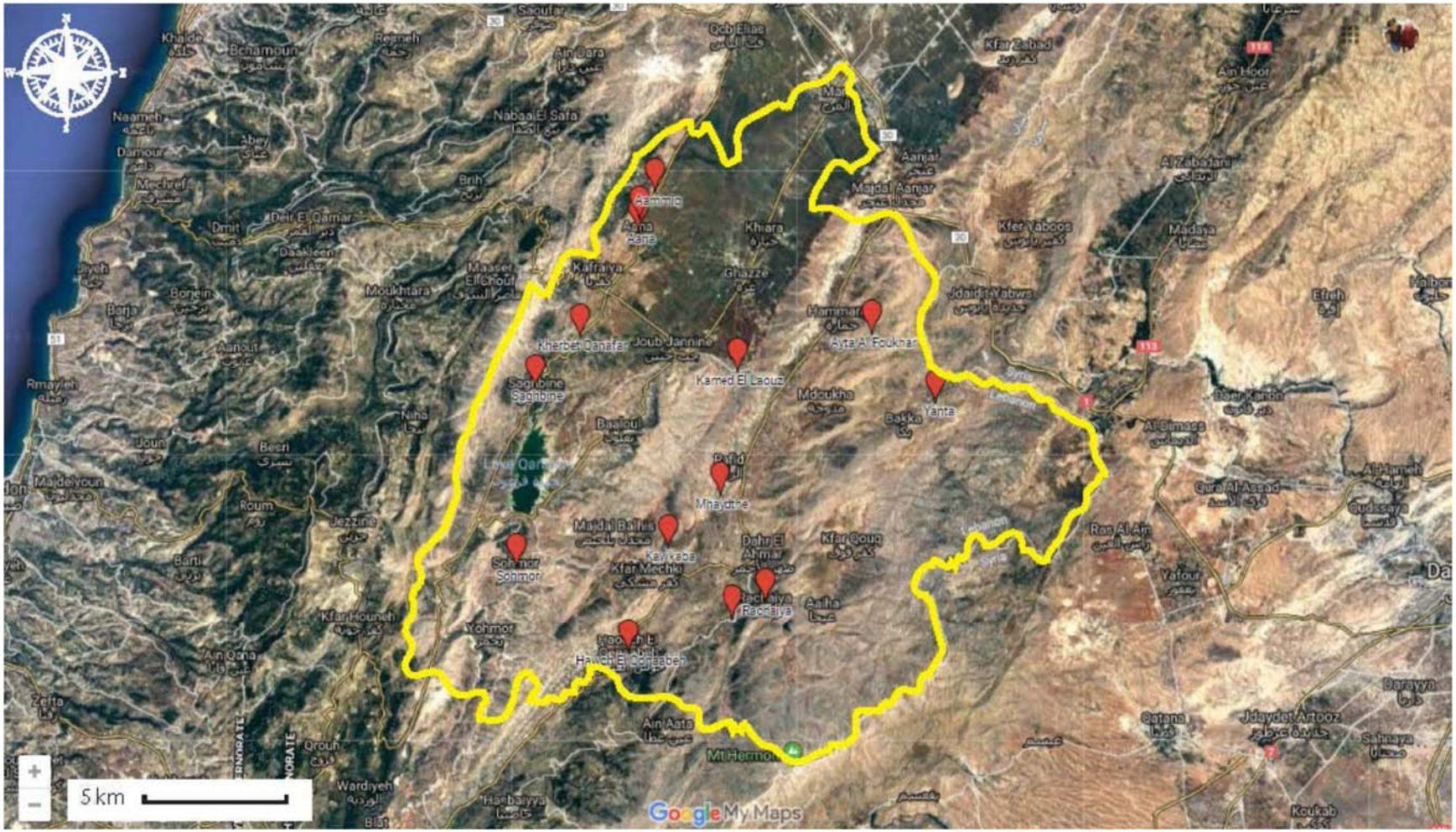

Figure 3: Distribution of the villages in the West Bekaa where small ruminant farmers were surveyed (Source: Google maps)

Figure 4: The Chouf expanding from the shorelines of Damour to the highest peaks of Mount Barouk (Source: Google maps)

2.1 The West Bekaa

2.2.1. Geography and climate

The Bekaa Valley is the largest agricultural part of the country (39% of the nation's agricultural surface) and comprises three zones: the arid northern Bekaa with large sedentary, semi-nomadic and nomadic herding systems, and rain-fed crops, the central Bekaa with large dairy farms and irrigated agriculture (vegetables, cereals and vineyards), and the West Bekaa, southern part of the valley, rich with large and small-scale dairies, big small-ruminants herds and mixed farming systems.

The West Bekaa is actually known for its fertile agricultural lands and receives between 700–750 millimeters of precipitation per year (Amery 2002). The region depends substantially on irrigation to grow crops especially during the long dry summers which frequently result in water shortages (Sheehan, 2008). Grains mainly wheat, grapes and livestock are key agricultural products (Verdeil et al., 2007).

The West Bekaa contains the largest artificial lake in Lebanon "the Qaraoun Reservoir" located on the Upper Litani River, which was constructed in the 1960's and has a total capacity of about 220 million m^3 and effective storage of 160 million m^3. The lake which supplies three hydroelectric plants generating about 7 to 10% of Lebanon's total annual power needs, ensures every year a total of 140 million m^3 for irrigation purposes divided between the South of Lebanon (110 million m^3) and the Bekaa (30 million m^3), in addition to 20 million m^3 for domestic purposes to the South (Aquastat, 2008). The Litani River, the longest river in Lebanon, flows towards the South of the country before emptying in the Mediterranean. Besides the Litani River, irrigation is provided from surface water (natural springs) and ground water (deep wells). Nevertheless, the river has been subject to several sources of pollution including municipal and industrial wastewater and agricultural discharges, in addition to anarchic exploitation and over-pumping leading to detrimental impacts on the health and economy of not only communities living around the river but the whole Lebanese population (LRBMS, 2012).

Figure 5: The Litani river during winter time: Mount Lebanon (in the background) covered with snow and separating the valley from the Chouf. Picture taken by the author on 13.01.13 in her hometown Saghbine

Figure 6: The Litani river after the snow has melted. Picture taken by the author during March of the same year (2013)

Climate change scenarios for Lebanon predict an increase of temperatures between 1.5 and 1.8˚C (MoE, 2001) and a maximum decrease of 15% in available water in the 2020s (Bou zeid and Al-Fadel, 2002). These changes coupled with variations in precipitation trends would affect the seasonality and production of major crops such as wheat, potato, apples and other, mainly in the Bekaa. Furthermore, it is expected that changes in temperature and rainfall will affect grazing period and pastures quality by changing the species composition in favor of woody and less palatable plants consequently finding pasture land for livestock will become harder (MoE and UNDP, 2011).

2.1.2. Demography

This southern part of the Bekaa valley includes the political districts of the West Bekaa (*Biqaa' Gharbeh*) and Rashaya; it comprises 57 villages (municipalities) and expands over 910 square kilometers. It is limited by the very arid Anti-Lebanon mountain chain from the east and by Mount Lebanon from the west. The West Bekaa is a multiethnic region with people from different religious backgrounds such as Christians (Melkite Greek Catholic, Maronite Catholic, and Greek Orthodox), Muslims (Sunnite and Shiite) and Druze, sometimes living all together in the same village.

Figure 7: Wheat harvest in the West Bekaa. Picture taken by the author on 25.6.2014

2.1.3. Agriculture and livestock production

The Bekaa Valley in general, offers good conditions for the production of high-value crops including vegetables and legumes, fruit trees, olive trees and industrial crops. These conditions are also favorable for the cultivation of cereals, mainly wheat and barley.

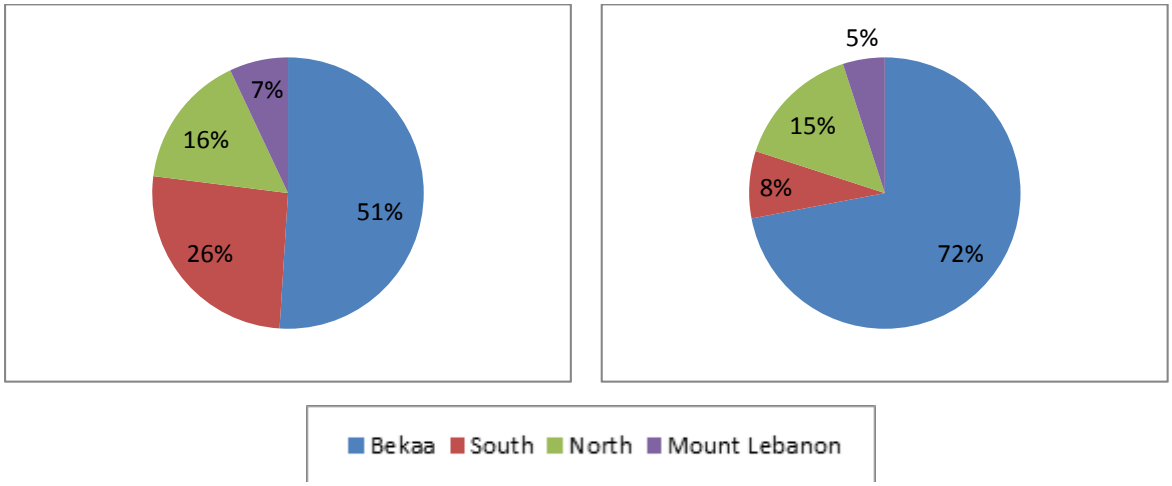

Figure 8: Distribution of goat population in Lebanon (on the left) and sheep population (on the right)

The Bekaa in general, holds the highest rates for sheep and goat on the national level (72% and 51% respectively), consisting of two local breeds: the rustic black goat known as *Baladi* and the fat-tailed Awassi sheep, both highly adapted to semi-arid conditions (Hamadeh et al., 1997; Silanikove, 2000; Jaber et al., 2004). Numbers of goats in the West Bekaa exceed those of sheep (Figure #) and are mainly reared for milk production. Sheep are more commonly raised by Bedouins in the central and Northern Bekaa. Nevertheless, goat meat is more appreciated in the north of the country, and sheep meat is more consumed in the West Bekaa and other regions. Although the highest concentration of small ruminants is in the northern Bekaa in Baalbeck and Hermel, the average herd size in the West Bekaa is the largest.

Figure 9: Herd of black Bedouin or Baladi goats and Awassi sheep grazing in the village of Ammiq – West Bekaa – March 2014

Figure 10: Herd of Awassi sheep grazing in the village of Ammiq – West Bekaa – March 2014

As for the dairy cattle, the average cattle holding size in the Bekaa region (Central and West Bekaa) is 21 heads whereas it is 7 on the national level; however, if only farms of less than 15 cows are taken into consideration, the average number of heads per exploitation would drop to 8.5 (MoA, 2012). Dairy cows raised in large farms belong to the Holstein breed, while small cattle herds consist of local or "*Baladi*" breeds and sometimes crossbreds of *Baladi*-Friesian, or even Holstein (Asmar, 2011). The Bekaa region in general contains 1,500 dairy cow keepers, 18,000 cows and 150 dairy processing units mainly traditional and of small size (Mikhael and Saadeh, 2014). And while the Central Bekaa hosts the large dairy farms and processing units of the country, the West Bekaa contains intensive dairy farms of different sizes, ranging from few heads to hundreds.

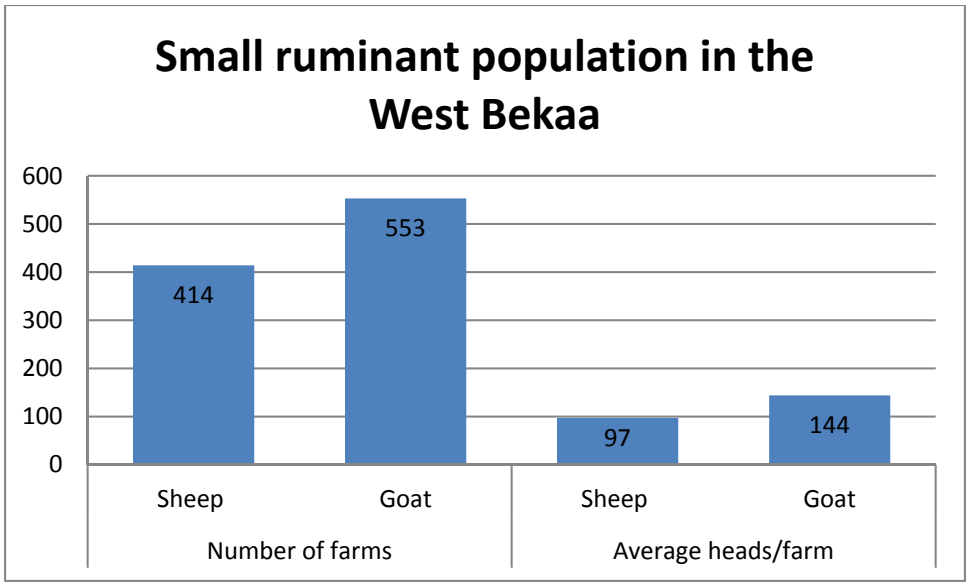

Figure 11: Number and size of sheep and goat farms in the West Bekaa (Source: Census of agriculture 2010 – Ministry of Agriculture 2012)

2.2. The Chouf

2.2.1. Geography and climate

The Chouf district is located at the southern part of Mount Lebanon, on the western slopes of *Jabal el Barouk* which separates the Chouf from the West Bekaa. The Chouf expands from the shorelines of Damour to the highest peaks of Barouk Mountains (1941m) over an area of 495 square kilometers, equivalent to 4.7% of the total area of Lebanon. It holds the largest Cedar forest in Lebanon as well as the Shouf Biosphere Reserve (SBR) stretching over 24 villages in the Chouf and West Bekaa (Hamadeh et al., 2005) and which attracts a lot of local and international tourists every year.

The Chouf incudes three distinct regions:

- The coastal plain between Damour and Rmeileh with a warm to warm and very humid climate;
- The middle region consisting of medium slopes on which are located the majority of villages and small towns of the Chouf. It has moderate temperature and humidity;

- The high mountains which are covered with snows during winter. The total annual rainfall in the region is estimated to 1000 mm. A great variation of precipitation is noted between the seasons with more than 80% of the rains falling between November and March.

The Chouf is rich in natural water resources with more than 55 springs and two big rivers the Damour river and the Barouk river

2.2.2. Demography

The Chouf is considered among the most religiously diverse areas in Lebanon and host Christian, Muslim and Druze communities, with the latter being the largest. Similarly to other rural areas in Lebanon, the Chouf is characterized by a high rate of immigration to the US, Canada and the Gulf countries mainly due to the lack of employment opportunities.

2.2.3. Agriculture and livestock production

This part of Mount Lebanon is an important agricultural area despite its mountainous and sloppy topography. Arable lands cover about fourth of the total surface of the Chouf and the region is renowned for the production of good quality olive oil produced from rain-fed groves occupying half of the permanent agricultural land, and has a good potential for wine production. Irrigation water for fruit trees and vegetables is provided from reservoirs, artesian wells and rivers (Hamadeh et al., 2005). It is characterized by small-scale agricultural exploitations and dairy farms usually selling their milk to local processing units linked to nearby small dairies for processing and sale and which contribute significantly to the economy of the area (Hamadeh et al., personal communication).

The general agriculture census includes the Chouf within the governorate of Mount Lebanon which comes in second place, after the Bekaa, in the size of cattle farms and in the third place after the Bekaa for the number of lactating cows with 14% of the total national herd (MoA, 2012). It contains 5% of the national ovine herd and 7% of the country's caprine herd.

Figure 12: The West Bekaa valley as seen from the Chouf mountain– June 2014

Figure 13: The Chouf as seen from the Chouf mountain– June

Figure 14: The men watch the herds in the pastures – village of Maasser el Chouf, June 2014

Figure 15: The women handle milking the animals and processing milk – village of Maasser el Chouf, June 2014

The rangelands of the Shouf Biosphere Reserve used to provide spring and summer grazing for a large number of small ruminant herds coming from villages close to the reserve but also from distant areas. Following the establishment of the reserve in 1997 and due to strict control applied by the reserve, grazing was limited only to herds from the region, hence the number of herds benefitting from the reserve rangelands dropped drastically. In the early 2000s, an integrated management plan was proposed in 2011 (Abi Said, 2011) in order to integrate grazing activities in the overall reserve management while ensuring a sustainable context for the reserve users and enhancing its local value. The plan included a grazing management program in cooperation with the reserve municipalities and an incentive package for the herders.

Figure 16: Medium-size dairy farm in Hilaliyeh village - Chouf

A survey by Hamadeh et al. (unpublished) in the Chouf region showed that 45% of interviewed small dairy holders practice animal husbandry as a family tradition complemented with fruits and vegetables production for subsistence. The study also showed that dairy

products from small scale dairies and local processors are of low quality and hygiene hence causing health risks to the consumers and jeopardizing the sustainability of the small sized dairy farms and “artisanal” processing unit.

2.3. The effect of the Syrian conflicts on the region of study

The year of 2014, when the surveys were conducted, depicts the fourth year of the conflicts in Syria and of the continuous movement of refugees towards neighboring countries including Lebanon. Given its proximity from the Lebanese-Syrian borders and the fact that it hosts the country’s largest official border crossing with Syria in Masnaa area, the Bekaa valley has received the highest number of Syrian refugees, as compared to other Lebanese regions (UNDP, 2017). This flow of refugees has added pressure on the already fragile services and increased the vulnerability of host communities, as they competed over employment, accommodation, access to public services, and infrastructure etc.

The West Bekaa in particular was reported among the governorates hosting the highest number of Syrian refugees with the highest number of employed Syrian women and the highest rate of women involved in agriculture (UNHCR, UNICEF & WFP, 2017). The Chouf from the other side, host the highest proportion of Syrian refugees who had fled conflicts in Syrian towards Mount Lebanon, and which is estimated to 83,000 refugees. Most of the Syrian refugees in Mount Lebanon live in urban settings; their increasing numbers creates pressure on water, waste disposal and local economy (Global Communities, 2014).

Syrians have traditionally provided the labor force in agriculture and construction even before the crisis. Today, about 15% of Syrian households are involved in agricultural activities, and agriculture is considered as the main livelihood for 9% of the families (UNHCR, UNICEF & WFP, 2017). However, the high numbers of refugees coming to Lebanon have created tension on the labor market, not only in the agricultural sector, as they work for lower salaries, for longer hours and without social security benefits, hence leaving host communities to struggle in order to sustain their livelihoods (FAO and MoA, 2014).

The Syrian crisis has aggravated the situation of the agricultural sector in Lebanon which was already suffering from institutional, technological and financial constraints; it has disrupted

the agricultural supply chains and changed trade patterns which resulted in increasing input prices. Moreover, in the areas close to the Syrian borders, farmers are not able to access their lands and are forced to abandon their farms (FAO and MoA, 2014).

3. Data collection

3.1. Literature review

A review of available literature relevant to the research topic provided a deeper understanding of the theoretical and research aspects of the topic. It allowed comparison between several case-studies and provided more insight about the different concepts (typology of farming systems, goat milk value chains, traditional food, local food systems, farmers' perception to change, adaptation strategies of small ruminants farmers etc.) that are addressed in this research project. Reviewed literature included peer reviewed articles, published books, project reports, internet websites in addition to public statistics and data etc.

3.2. Survey

The preparatory phase of this thesis project included several consultations with colleagues at the American University of Beirut, the Lebanese University – Faculty of Agricultural and Veterinary Sciences, the Agricultural Research Center (ARC) – Animal Production Research Institute (APRI) in Egypt, Cirad in Montpellier – France (GREEN and SELMET units), the Mediterranean Agronomic Institute of Montpellier (IAMM) etc. to exchange points of view in regard to this project and relevant works as well as methodologies for data collection and analysis. These consultations with people working either in research or/and development were very helpful in defining the framework of the research question and hypothesis.

The collection of primary data was done through two surveys, each one part of a different research project in which I was involved. Both research projects served the thesis and aimed at investigating in the research questions; the first project investigated the question on the sustainability of small ruminant farming systems in the West Bekaa, their challenges and adaptation strategies, from the perspective of the farmers. The second project aimed at

assessing the sustainability of these systems as reflected by the value chain of “kishk” a typical cheese that is traditionally produced from goat milk in the West Bekaa and the Chouf.

3.2.1. Perception of the West Bekaa farmers to change and their adaptation strategies

The first survey was part of a research project that was financially supported over two consecutive years (2014-2015) by the Research Board of the American University of Beirut (URB). The main objective of this research project was to classify small ruminant systems in the West Bekaa and to assess their adaptive mechanisms with reference to flock management, feed resources, livelihood strategies and grazing routes under the effect of different stressors including climate variability. The questionnaire (Annex 1) was designed to collect data from the small ruminant producers and identify their challenges and perception of change; it comprised nine sections with open-ended and closed-ended questions allowing the collection of as much data as possible to understand the farm composition, its dynamics, the herd composition and management, the farmers’ challenges and perception to change as well as their adaptation strategies.

- Section 1 comprised questions related to the social status of the farmer including questions on his marital status and family composition and educational background;
- Section 2 addressed the social composition of the farm (labor force involved in the farm management) and its social links;
- Section 3 comprised questions related to the farm history and its current status;
- Section 4 addressed land-use and crop production;
- Section 5 focused on animal husbandry including herd composition and management, feeding strategies and pasture use etc.;
- Section 5 involved questions about milk value chain (volume of milk produced, routes of sales, milk processing, prices etc.);
- Section 7 addressed the economic status of the farm (expenses, income and financials);
- Section 8 was about the farmers’ perception to change during their years of involvement in animal husbandry activities;

- Section 9 addressed the on-farm changes and adaptation strategies adopted by the farmers.

Figure 17: Instead of going to school, the little Syrian boy is helping his father watching the herd – March 2014, village of Kherbet Qanafar, West Bekaa

3.2.2. Sustainability of the production chain of traditional *kishk* in the West Bekaa and Chouf

The second survey aimed at collecting data to assess the value chain of the traditional dairy product "kishk" in the West Bekaa and Chouf where this product is commonly produced and represents an integral part of the rural diet. This part of the research project was financially supported by the Lebanese National Scientific Research Center (NSRC) for a period of two consecutive years (2013-2014). The project objective was to assess the value chain of "kishk" for better conservation of its agrobiodiversity resources namely durum wheat and milk derived from the local breed of goats. Data was collected through a questionnaire based on open-ended and closed-ended questions related to the production practices and selected socio-

economic aspects: it included one part addressed for the wheat farmers and one part for the kishk processors (Annex 2). The questionnaire included the following six sections:

- Section 1 included screening questions to make sure the right interviewees are selected (wheat farmers of kishk producers);
- Section 2 comprised questions related to farming practices and farmers' knowledge;
- Section 3 entailed questions relevant to the social sustainability of the farm (social linkages and people involved in the farm) and the quality of the products;
- Section 4 addressed the future of the farm and willingness of the farmer to sustain wheat production;
- Section 5 included questions related to the socio-economic conditions of the farmer/producer (gender, age, education, household income etc.);
- Section 6 was directed to the kishk producers and included questions related to the processing practices they adopted, their input sources, their marketing channels etc.

Figure 18: More goat milk is added to the "kishk" mixture (cracked wheat, yogurt and salt) daily over four days, then the mixture is kneaded – Saghbine, West Bekaa July 2014

Figure 19: Spreading boiled wheat on the roof: a task which not only brings family members together, but also tourists to watch. The wheat is then ground into bulgur which is consequently used for "kishk" production – Saghbine, West Bekaa, July 2014

3.2.3. Family dairy farming systems in the West Bekaa and Chouf

A third survey was conducted in parallel to the two previous ones, and aimed at collecting data on family dairy farming systems in the West Bekaa and Chouf. In the light of very limited data on family dairy farming systems in Lebanon, the aim of this survey was to identify the different types of these systems that exist in the West Bekaa and Chouf, understanding their structure and management practices, discuss the their different challenges and highlight the importance of carrying a farming system typology to facilitate the planning of developing projects and policies.

This study relied on quantitative and qualitative data collected through a survey covering family dairy farms in the West Bekaa and Chouf-Aley. Contacts of farmers were obtained from previous projects and from key informants in both regions. Snowball sampling was also used as interviewed farmers helped identifying and locating other farmers in the region (Goodman, 1961).

A total of 40 dairy farms, 13 in the West Bekaa and 27 in the Chouf, were visited in 22 villages. A questionnaire (Annex 3) including open-ended and closed-ended questions was used to collect data related to the structure of the farming system (animal husbandry, crop production, land tenure, equipment, housing), its dynamics (changes in activities and herd size over the past years), herd management (herd composition, feeding, insemination methods, reproduction), marketing of products mainly milk and processing of dairy products. Information on the social status of the farmer (age, educational level, family structure) was also gathered using the same questionnaire. It is worth to mention that record keeping was done only for cows' calving, and it was difficult to get accurate numbers on the financials of the farm in terms of expenses and profits.

3.3. Secondary data from short movies on rangeland socio-ecosystems

The Livestock Farming System and Local Development (LIFLOD) network, coordinated by the Federal University of Santa Maria (UFSM) in Rio Grande do Sul Brazil, has developed a research project focused on the perception of the value of rangeland by the communities living there. The research is based on short movies run by contrasted rangeland communities in order to present to other communities their respective biomes, their lives of breeders, their herds and pastures, the main topics of debate and conflicts in their regions, and their scenarios for the future. This research, always in progress[1], is supported by diverse donors, as mentioned below.

The short movies are available on Youtube, as indicated below for each movie. The general format (guidelines) of the short movies was decided during a one-week workshop held in Montpellier in May 2016 with the participation of thirty young and some proficient researchers and stakeholders from contrasted rangeland areas located in approximately ten livestock countries in the five continents.

After the Montpellier workshop, seven short movies, each of around 15-20 minutes, were produced in the following rangeland areas as indicated on the map (Fig. 18): the Qilian

[1] The research project is currently coordinated by UFSM in the framework of the NEXUS Project (Livestock Farming Systems in the Basin of Ibirapuitã Rio and its Links with Water, Energy and Food Production, supported by the Brazilian National Council for Scientific and Technological Development – CNPq).

Mountains in North-Eastern Tibetan Plateau, China; the Serra Gaucha, Rio Grande do Sul, Brazil; the Uruguayan Pampa; the Special Areas in the Great Plains, Alberta, Western Canada; the Bedouin area of North Western Coast Zone (NWCZ) in Egypt; the Mediterranean Mountains in Southern France; and the Ferlo in the Sahel biome of Northern Senegal.

- The first short movie was prepared in the framework of the project "The Sustainability of Farming System Facing Global Change in the Qilian Mountains, Tibetan Plateau, China"[2] supported by the *Cai Yuanpei Program*[3]. This movie was produced by *AgroParisTech*[4] France in collaboration with the International Center for Tibetan Plateau Ecosystem Management (ICTPEM) of *Lanzhou University*[5], China and LiFLoD network.
- The second movie[6] was run in the *Serra Gaucha*, Southern part of the Atlantic Cordillera, located in the Rio Grande do Sul State, Brazil. It was produced by the *Post-Graduate Program in Rural Development* of *Federal University of Rio Grande do Sul*, Brazil (UFRGS-PGDR[7]) in the framework of CAPES-PVE 298115 Project[8] funded by Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) in Brazil.

[2] www.livestockdialogue.org/cases/detail/en/c/23/
[3] www.campusfrance.org/fr/caiyuanpei
[4] www.agroparistech.fr
[5] www.en.lzu.edu.cn
[6] https://lume.ufrgs.br/handle/10183/186133
[7] www.ufrgs.br/pgdr/ingles/institutional
[8] Livestock – Sustainable Local Development Interaction in Brazil and its links with other regions of South America and World – supported by CAPES, Brazil

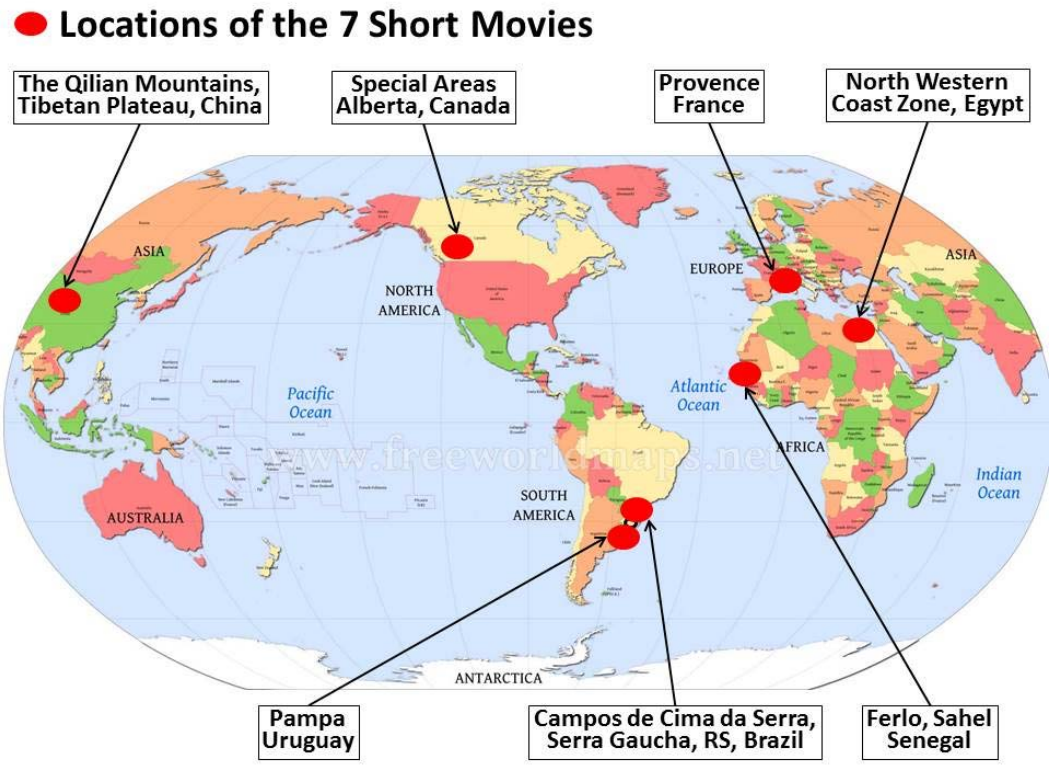

Figure 20: Map showing the locations of the seven short movies that were produced on the value of rangelands

- The Third movie[9] was run in the Uruguayan Pampa by *Instituto Plan Agropecuario* (*Crop – Livestock planning Institute*[10]) in the framework of the MOUVE Project (Livestock and Local Development interactions and the ecological intensification) supported by *Uruguayan Ministry of Livestock, Agriculture and Fisheries* (MGAP[11]) and the *French National Agency of Research* (ANR[12]).
- The fourth movie[13] was run in *The Special Areas* located in the Western Canadian Great Plains, Alberta Province, Canada, in the framework of "Restoring Value of Rangeland" project, supported by Focus Area 2 / Global Agenda for Sustainable Livestock (FA2-GASL)[14] and CAPES-PVE 298115 Brazilian Project.

[9] https://www.youtube.com/watch?v=W4lBBo89ipM
[10] www.planagropecuario.org.uy/
[11] www.mgap.gub.uy
[12] www.agence-nationale-recherche.fr
[13] https://www.youtube.com/watch?v=ickPGYg1H3E
[14] http://www.livestockdialogue.org/

- The fifth movie was run in the Bedouin area of the *North West Coast Zone* (NWCZ), Egypt, produced by the Desert Research Center (DRC[15]) and the Agricultural Research center (ARC[16]) in the framework of "Restoring Value of Rangeland" project, supported by local institutional funds and FA2-GASL.
- The sixth movie was run in the Mediterranean Mountains of Southern France in the framework of "Restoring Value of Rangeland" project, supported by local institutional funds and FA2-GASL.
- The last and seventh movie[17] is a Forum Theater run in the Ferlo, part of Senegal Sahel in the framework of the "VoiPastorales" project (Débattre des trajectoires des sociétés pastorales / Discussing the trajectories of the pastoral societies) and produced by Cirad[18] in partnership with diverse local and national Senegalese institutions. In this movie, local stakeholders share their point of view about strategies of adaptation and transformation facing global changes.

[15] www.drc.gov.eg
[16] www.arc.sci.eg
[17] www.youtube.com/watch?v=fx30c9xjbfc
[18] www.cirad.fr

Figure 21: Rangelands of the Serra Gaucha, Rio Grande do Sul (Source: Carine Pachoud)

Figure 22: Serra Gaucha, Rio Grande do Sul : the young lady is a farmer who decided to manage the farm after her parents, which is very rare in the region (Source: Carine Pachoud)

Figure 23: Feed production in the Qilian mountains, Tibetan plateau during summer (Source: LIFLOD Network)

Figure 24: Yak farm in the Qilian mountains, Tibetan plateau during end of winter (Source: LIFLOD Network)

Figure 25: Herd on the move during the dry period in Ferlo, Senegal (Source: LIFLOD Network)

Figure 26: Sheep feeding during the dry season in Egypt (Source: LIFLOD Network)

Figure 27: Concentrate and hay in Neguila market, NRWC, Egypt (Source: LIFLOD Network)

Figure 28: Cattle grazing in the field during autumn in Alberta, Canada (Source: LIFLOD Network

Figure 29: Feeding the cattle during winter in Alberta, Canada (Source: LIFLOD Network)

Figure 30: Cultivated pastures in the South of France (Source: LIFLOD Network)

Figure 31: Pastures in the Mediterranean Alps (Source: LIFLOD Network)

Figure 32: Cattle in the range – North Uruguayan Pampa (Source: LIFLOD Network)

4. Data analysis

The different methodologies that were used to analyze the collected data are listed below:

4.1. Perception of change of small ruminant farmers in the West Bekaa

Assessing farmers' perception has emerged in the early 2000's as a mean to scientifically understand farmers' knowledge about a certain topic. Farmers' perception to climate change and their adaptive strategies are one of the main topics that have been investigated especially in the African countries with the aim of enhancing farmers' adaptive capacities to the effects of climate change (Sani and Chalchisa, 2016; Tesfahunegn et al., 2016; Elum et al., 2017). Farmers' perception to risk and risk management is also a widely addressed topic in the literature (Palinkas and Szekely, 2008; Sulewski and Kłoczko-Gajewska, 2014).

According to Elum et al. (2017), "one's perception is shaped by experimental and indigenous knowledge [of the climate] as well as given the observed impact [of climate change]. Concurrently, Sani and Chalchisa (2016) found that farmers' perception to climate changes is affected by different factors including farmers' access to information and extension services, farmers' wealth and their experience in farming. Hence, information about farmers' perception is generally collected through questions related to farmers' experience (Elum et al., 2017).

Considering farmers' perception while assessing small ruminant systems and planning development programs and policies, results in the formulation of appropriate policies and programs accepted by the farmers (Olafsdottir and Juliusson, 2000; Ho and Azadi, 2010; Zampaligre et al., 2014). Although many do not acknowledge pastoralists' opinions and consider their behavior as "irrational" (Ho and Azadi., 2010), researchers agree today that integrating the perception of land users - farmers and pastoralists – in their studies, would have advantageous implications on their understanding to rangeland ecology, land-cover changes, climate variability and climate change (Olafsdottir and Juliusson, 2000; Barbier et al., 2009; Mertz et al., 2009).

Figure 33: Iyad, a shepherd from the village of Kamed el-Loz - West Bekaa, perceives land tenure systems as main cause of pasture segmentation

Assessing the perception of small ruminant farmers in the West Bekaa to changes occurring around them and their impact on their production systems would provide valuable information on their adaptive strategies within the present dynamics of the Syrian influx and persistent climate variability. It will also help in proposing policies and development programs that fit the farmers' perception and their needs.

4.2. Typology of small ruminant farming systems in the West Bekaa

Classifying homogenous farms in one group or cluster, called farming systems typology, helps distinguishing different types of farms having the same characteristics and facing similar problems. Farming systems typology allows identifying the strengths and weaknesses of the farms under one group and facilitates planning of adequate development strategies and agricultural production programs, implementing efficient policy interventions, effective extension service and transfer of adequate technologies, climate change mitigation, and improved pasture management etc. (Mądry et al., 2013; Vanclay et al., 2005; Alvares Lopez et al., 2008; Chatterjee et al., 2015). In marginal areas, farming systems typology allows for a better understanding of the existing systems and an increased promotion of the opportunities

in these areas (Mądry et al., 2013). Hence, farm systems with similar resource bases, crop-livestock production combinations, agricultural and non-agricultural economic activities performed by the farm household members, generated income, and natural, social, infrastructural and institutional resources are classified under one group of farms or farming system (Köbrich et al., 2003; Bertaglia et al., 2007); those for which similar development strategies and recommendations are suggested, are also placed under the same farming system (Köbrich et al., 2003).

The size and characteristics of the sampled farms should be representative of the size and characteristics of the farms in the research area. Both qualitative and quantitative data are used in farming systems typology; the qualitative data is usually used when data is scarce, and it is mainly related to the farm activities, features of the rangelands, type of feed, presence of infrastructures and equipment, animal performance, type of reproduction management etc. and offers a description of the farm, its structure and activities (Castel *et al*., 2003). Sometimes, qualitative data is transformed into quantitative data and is expressed in percentages (Castel *et al.,* 2010). Quantitative data include information on the farm and agricultural land surface, herds' size, animal density, labor, quantities of feed, production and productivity of herds and crops, economic data such as income and expenses etc. It is generally used for multifactorial analysis (Mądry et al., 2013). When some variables are strongly correlated, the most important one is used for the analysis (Lesschen *et al.,* 2005).

Multivariate analysis is widely used in farming systems typology (Guto et al., 2010) and includes two steps: the principal component analysis (PCA) and the cluster analysis (CA). PCA allows reduction of the number of initial variables to a limited number called principal components containing the most important information characterizing the entries with relatively little loss of information (Lesschen et al., 2005); and the CA identifies the different types of farms or clusters gathering similar farms (Chatterjee et al., 2015). According to researchers (Castel et al., 2003; Kobrich et al., 2003; Gaspar et al., 2008), the number of clusters should not be too large but limited to 3-6 clusters. The next phase in farming systems typology is validating the obtained results through field surveys to make sure that the obtained clusters are real and represent the farming systems in the area of study. The last phase would be

comparing the different clusters by simple statistical analysis using one-way ANOVA or chi-squared test to obtain a spatial distribution of the farms (Mądry et al., 2013).

Typology of systems is fairly documented and provides a comparative platform. Within this framework, a typology of the small ruminant farms surveyed in the West Bekaa region was conducted in order to identify the different types of existing farming systems and allowed a better understanding of these systems, their structure, potential and challenges, and consequently formulating adequate interventions and policies that would serve the planning of development projects and setting of adequate policies whether on the local (municipality and/or caza) or national level.

Figure 34: Botrous (Peter) descends from a family of shepherds. He is retired today and his son has taken his place. While Botrous used to roam the pastures with his herd, his son has a Syrian shepherd who does the work for him – Saghbine, West bekaa, July 2014

4.3. Value chain analysis of kishk in the West Bekaa and Chouf

The value chain (VC) concept is a systems approach that evolved over time while drawing from different disciplines (da Silva and de Souza Filho, 2007). A food value chain is defined as the set of activities involved in the production of a food (kishk in the case of this study), starting from its conception with basic raw materials (wheat and goat milk in this study) to its delivery to final consumers, and going through all the intermediary phases (Hellin and Meijer, 2006; Nang'ole et al., 2011). As the product moves from one chain to another, it gains value from higher prices, or an expanded market or from differentiating it from other similar products (for instance geographical location, environmental stewardship, food safety etc.). A VC can vary from a horizontal and simple one to a more complex chain where input and output chains comprise more than one channel which can also supply more than one final market (Kaplinsky and Morris, 2001; Hellin and Meijer, 2006).

"The 'filière' or commodity approach is an old concept of the VC concept, dating back to the 1950's (Roduner, 2004); it was developed at the French "Institut National de la Recherche Agronomique" (INRA) and the "Centre de Coopération Internationale en Recherche Agronomique pour le Développement" (CIRAD) as an analytical tool to study the ways in which agricultural production systems were organized in the context of developing countries" (Nang'ole et al., 2011). The "filière" approach is usually seen as having a static character, representing the relations between the different actors at a certain point in time, and in opposite to the "VC system" which is dynamic, it does not reflect the changes that the product goes through (Roduner 2004). The concept of "filière" has been broadened over time to coincide today with the VC concept (FAO, 2014).

Although a value chain analysis was primarily developed as a tool for enterprises to identify their sources of competitive advantage, maximize their revenues and enter global markets (Kaplinsky and Morris, 2001), it is widely used by development practitioners to improve development intervention strategies that address economic growth and aims to reduce poverty and ensure sustainability of these strategies (Nang'ole et al., 2011; Bhandari and Thomas, 2013). Concurrently, the FAO (2014) has introduced the concept of "Sustainable Food Value Chains" which is defined as "*the full range of farms and firms and their successive*

coordinated value-adding activities that produce particular raw agricultural materials and transform them into particular food products that are sold to final consumers and disposed of after use, in a manner that is profitable throughout, has broad-based benefits for society and does not permanently deplete natural resources". A VC can be either global or local with the latest offering more opportunities of integration to smallholder farmers as they are less expensive and simpler than the global CV (Lie et al., 2012). However, a VC is deemed effective when the generation of value is maximized while small holders are empowered (Dubeuf et al., 2016).

The market map is a first step to take when analyzing a VC. It is a conceptual and practical tool that allows us identifying the policies that regulate the market, the institutions that offer services and the VC actors who make their decisions accordingly. The market map includes 3 main interlinked components:

- The players or value chain actors who manage the product as it flows from one VC to another. They include the suppliers, farmers, traders, processors, transporters, wholesalers, retailers and final consumers;
- The market enabling environment which includes the critical factors and trends that shape the value chain environment and affect its functioning; these are generated by the institutions (policies, regulations and infrastructures) and the infrastructures (research agencies, local and national authorities);
- The service providers which support the efficiency of the value chain and add value to the products. These include among others the extension, financial and transport services, quality assurance and market information.

Collected data can be qualitative and/or quantitative; however it is more recommended to start with gathering the qualitative data which is done through semi-structured interviews and focus group discussions. Quantitative data is collected later through surveys and questionnaires (Hellin and Meijer, 2006). Secondary sources are also used for data collection and include

government statistics and literature review (Hellin and Meijer, 2006; Bhandari and Thomas, 2013).

The VCA has not been broadly used in the small ruminant sector in order to optimize the benefits of smallholder goat keepers (Dubeuf et al., 2016). However, the available literature includes research studies and reports of development projects, from different part of the world, reporting the use of this methodology to explore possibilities of effective participation of smallholder farmers in the dairy value chain while efficiently developing the latter (Gómez-Ruiz et al., 2012; Lie et al., 2012), seek ways to improve the small ruminant cheese sector and reviving traditional goat cheese (Rytkönen et al., 2013; Tsiboukas and Vallerand, 2004), identify interventions to improve productivity, processing and marketing of goat safe meat and milk (Weber et al., 2018) and empower rural women (Hegde and Deo, 2015).

In the current study, the VCA was used to assess the processing of the traditional dairy product “kishk” to analyze its sustainability in two contrasted regions the West Bekaa and Chouf, especially under the impact of the fluctuating availability of its two main ingredients wheat and milk, and the impact of the changes in the production system.

Figure 35: Young Druze sheikh taking the herd to the farm – village of Rashaya, West Bekaa, June 2014

4.4. Typology of family dairy farming systems in the West Bekaa and Chouf

The history of the dairy sector in Lebanon shows that the sector has always been fragile, and the fluctuations that have occurred all through the years, suggest that there is a lack of pre-project assessment, and development programs or policies have been planned and implemented without taking into consideration the different existing farming systems. Nonetheless, the inefficiency and unsustainability of these programs and policies prove that top down approaches prevent the involvement of key stakeholders – mainly beneficiaries (farmers and processors) – in the planning process and the decision-making (Rached, 2002). Dairy farms in the West Bekaa and Chouf are namely family farms linked to traditional and small-sized processing units, and the whole system suffers from poor planning and poor infrastructure (Haddad and Chamoun, 2014). A typification of the family dairy systems in the West Bekaa and Chouf would provide valuable data on the existing systems and their management strategies as well as the challenges they face and consequently their adaptive measures. However, collected data has not been completely analyzed; and although a preliminary typology of the systems has been done, results are not finalized and have not been included in this thesis manuscript but will rather be finalized and submitted for publication later.

Figure 36: Qassem, an old farmer from the village of Mashghara, West Bekaa, works alone in his farm (8 cows)

4.5. Video content analysis

The use of movies as secondary data in research is gaining more popularity especially that simple technologies such as smart phones and computer softwares for editing are made available to everyone and are also easy to use. Films and videos are used in qualitative research either as data collection tools or sources of information and dialogues between researchers and participants and also as mechanisms for disseminating research results (Given, 2008). Jewitt (2012) presents the different types of videos that are used for research:

- The participatory videos usually used in the context of development, health programs and marginalized communities to explore people's experiences and reduce the gap between the concept and the model;
- The videography which is an ethnographic approach to video making which gather data to stimulate critical reflection;
- The elicitation which is used with interviews or focus groups to prompt discussion, stimulate the memory or provide a basis for reflection;
- The video-based fieldwork commonly used in social sciences which involves recording on-going interaction with people in a specific context and environment;
- The use of existing video data (case of this project) where the researcher analyses video data that is produced by someone else. This type of video data is widely used in research and involves analyzing existing data rather than generating videos. When using this type of data it is recommended to understand the history and context of production of the video as well as its original purpose and audience.

In the LIFLoD research, the short movies are used for diverse goals including graduate and post-graduate courses, trainings of breeders and technicians, sharing local knowledge, comparing local and scientific knowledge, information of breeders, scientific and science-society communication, etc. In the specific case of this thesis, we have referred in the short movies particularly to the discussions about the gaps and challenges of the rangeland areas and which were previously identified in the Lebanese case study (Chapter 1). The objective is to

upscale the Lebanese rangeland gaps and challenges while comparing them with the perception of breeders from diverse and contrasted rangeland areas.

5. Supporting projects and research studies

Between 2013 and 2019, I have been involved in the following research projects that relate to my research project. In the absence of specific financial support, i.e. scholarship dedicated to the thesis, my involvement in these projects allowed me to conduct my surveys, collect the data I needed and discuss the obtained results with other researchers and scientists.

- Survey and quality assessment of the small scale dairy sector in Mount Lebanon (2012-2013); financed by the University Research Board of AUB
- Value chain analysis of wheat landraces and wheat-based traditional foods in relation to agrobiodiversity (2013-2014); financed by the National Council for Scientific Research in Lebanon (CNRS-L)
- Adaptation strategies of small ruminants' production systems to environmental constraints in semi-arid areas of Lebanon – Shouf and West Bekaa (2014-2015); financed by the University Research Board of AUB
- Testing the resilience of small ruminant systems – case study of the West Bekaa (2016-2018); financed by the University Research Board of AUB
- Assessing the value chain of caprine dairy products' in the West Bekaa and Chouf (2018-2019); financed by the University Research Board of AUB

I have also been involved in two research and development (R&D) projects which relate to my research work:

- "Sustainable livelihoods in semi-arid areas: Adapting agro-pastoral systems to climate change and empowering rural women (2013): a series of capacity-building workshops to small ruminant farmers and milk processors in the West Bekaa, financed by the German Society for International Cooperation, Ltd (GIZ)
- "Climate-Smart Livelihoods Initiatives and Market Access Tailoring (CLIMAT)": a food for training project aiming to sustainably improve the skills, capacities and livelihood

opportunities of vulnerable Lebanese and Syrian refugees in Northeast Baalbeck and West Bekaa. The project funded by the German Cooperation through WFP, is planned and managed by the Environment and Sustainable Development Unit (ESDU) at the American University of Beirut in partnership with Cooperation without Borders (CWB). It tackles 3 value chains: the small ruminant production (wool and carpet production, dairy processing and herd/pasture management), alternative and climate-smart agricultural crop production and agro-food processing.

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RESULTS

This part includes three research studies that were conducted in Lebanon: the first one study identifies the production constraints as perceived by small ruminant farmers in the West Bekaa and analyzes their adaptive strategies; the second study analyzes the value chain of a traditional cheese “kishk” typically prepared in the West Bekaa and Chouf with goat milk. It aims at assessing the sustainability of this product under the impact of the changes that have occurred in its two main ingredients: wheat and goat milk; and the third study describes the family bovine systems in both the West Bekaa and Chouf, based on a typology, as an intensification model for some agro-pastoralists especially for fattening lambs and culled ewes, improving reproduction and growing indices, developing small ruminants’ milk and dairy processing.

CHAPTER III: FARMERS' PERCEPTION TO CHANGE AND ADAPTATION STRATEGIES OF SMALL RUMINANT SYSTEMS IN THE WEST BEKAA OF LEBANON

Perception des fermiers vis-à-vis du changement et des stratégies d'adaptation des systèmes de petits ruminants dans la Béqaa Ouest au Liban

Résumé

La production ovine et caprine dans la région MENA est soumise à des pressions économiques, environnementales et sociales entraînant des changements majeurs dans les systèmes de production. Cette étude examine les principales contraintes affectant la production de petits ruminants dans la Béqaa Ouest au Liban, telles que les perçoivent les fermiers, et leurs stratégies d'adaptation signalées. Quatre systèmes semi-sédentaires ont été identifiés : i) avec des bergers sans terre, de petits troupeaux et un accès aux résidus de cultures, ii) avec des petits troupeaux et aucun accès aux résidus de cultures, iii) avec des troupeaux de taille moyenne et un accès aux résidus de cultures et iv) avec de grands troupeaux. Les agriculteurs de tous les systèmes ont estimé que les contraintes de production étaient liées à l'accès et à la qualité des pâturages (25% des réponses signalées) et à la variabilité du climat (22,5% des réponses rapportées). Les incertitudes politiques et celles du marché (24,5% des réponses rapportées), les conditions socio-économiques à la ferme et la santé animale ont également été rapportés comme des défis de production. Les systèmes comportant de plus grands troupeaux étaient davantage affectés par les fluctuations des prix du marché et du coût de la main-d'œuvre que les systèmes comportant de petits troupeaux. En l'absence de soutien gouvernemental, les agriculteurs de tous les systèmes ont mis au point des stratégies d'adaptation à court terme qui impliquaient principalement plus de temps consacré aux pâturages (88% des agriculteurs), davantage de compléments alimentaires (67% des agriculteurs ont complété en moyenne 1 kg d'orge/ animal / jour) et une diminution de la taille du troupeau (61% des agriculteurs). Le changement du mouvement du troupeau était également pratiqué mais dans une moindre mesure en raison de l'accès limité aux pâturages et aux politiques locales. Les systèmes de petits ruminants dans la Béqaa Ouest deviennent de plus en plus sédentaires face aux pressions environnementales et aux incertitudes du marché perçues par les fermiers, tout en diversifiant leurs stratégies d'adaptation.

Farmers' perception to change and adaptation strategies of small ruminant systems in the West Bekaa of Lebanon

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Abstract:

Sheep and goats production in the MENA region faces economic, environmental and social pressures causing major shifts in the production systems. This study investigates the main constraints affecting small ruminant production in the West Bekaa of Lebanon as perceived by the farmers, and their reported adaptive strategies. Four semi-sedentary systems were identified i) with landless shepherds, small herds and access to crop residues, ii) with small herds and no access to crop residues, iii) with medium sized herds and access to crop residues and iv) with large herds. Farmers from all systems perceived production constraints as related to pasture access and quality (25% of reported answers), and climate variability (22.5% of reported answers). Market and political uncertainties (24.5% of reported answers), on-farm socio-economic conditions and animal health were also reported as production challenges. Systems with larger herds were more affected by fluctuations in market prices and labor cost than systems with small herds. In the absence of the government support, farmers from all systems developed short-term adaptive strategies which mainly involved more time spent on pastures (88% of farmers), more feed supplementation (67% of farmers supplemented an average of 1Kg of barley/animal/day), and a decrease in herd size (61% of farmers). Changing herd movement was also practiced but to a lesser extent due to restricted access to pastures and local policies. Small ruminant systems in the West Bekaa are becoming more sedentary under environmental pressures and market uncertainties as perceived by the farmers, while diversifying their coping strategies.
Keywords: small ruminant systems; Lebanon; adaptation strategies; farmers' perception

1. Introduction

In Lebanon, goats and sheep hold a key role in the economy of marginal regions and contribute to the income of the population involved in pastoral activities (Hamadeh et al., 1996). The small ruminant production systems identified in the country range from transhumant to semi-nomadic and semi-sedentary systems and vary in the mobility of the herds, their use of rangelands, their size and composition (Hamadeh et al., 1996; Hosri and Nehme, 2006).
The size and management of the goats and sheep national herd have shown instabilities over the last fifteen years reflecting the effect of environmental and climatic constraints, depletion of natural pastures, increasing urbanization and inappropriate agricultural policies (Hosri et Nehme, 2006; Darwish and Faour, 2008). This trend has been accentuated in recent years in the Bekaa valley due to the influx of Syrian refugees and their small ruminant flocks (FAO, 2014).
However, the small ruminant sector in the Middle East and North Africa (MENA) in general, and Lebanon in particular, has managed to maintain its production by developing adaptation strategies in the face of drought and scarcity of natural resources, leading to shifts from a transhumant system to a more sedentary and crop-based one (Hamadeh et al., 1999; Bistanji et al., 2000; Alary et al., 2016). Nevertheless, questions on the sustainability of these systems have been raised (Alary et al., 2016).
The small ruminant sector of the West Bekaa is largely understudied in comparison to that of the more arid North Bekaa. However, this region of Lebanon hosts a large proportion of the small ruminant farmers that are also subjected to a myriad of the challenges including climate variability and the Syrian refugees' influx. The assessment of this sector would provide valuable information on the perceived challenges and adopted strategies of these systems. This would be helpful in highlighting the regional differences, if any, within the country and thus allow for improved targeted interventions in the future.
Taking farmers' perception into consideration while assessing small ruminant systems and planning development programs and policies, leads to formulating appropriate policies and programs accepted by the farmers (Ho and Azadi, 2010, Zampaligré et al., 2014). Although many do not acknowledge the pastoralists' points of view and consider their behavior as "irrational" (Ho and Azadi., 2010), a new trend is emerging among researchers (Barbier et al., 2009; Mertz et al., 2009) who agree that integrating the perception of land users – farmers and pastoralists – in their studies, would have advantageous implications on their understanding to rangeland ecology, land-cover changes, climate variability and climate change.
In the absence of literature on the perception of farmers to change in the MENA region, this paper aims at identifying the adaptation strategies of the small ruminant production systems in the West Bekaa of Lebanon to existing and emerging challenges, based on the farmers' perception of change and its driving forces.

2. Materials and methods

2.1. Description of the region of study: The West Bekaa

The West Bekaa, one of the most fertile regions of Lebanon, falls in the southern part of the Bekaa valley on an average altitude of 1000m above sea level with 700-750ml of precipitation per year. It is limited by the Anti-Lebanon mountain chain from the east – making the borders with Syria – and Mount Lebanon from the west. The West Bekaa region hosts large numbers of small ruminants estimated to 80,116 (38.8% of the Bekaa goat herd) and 40,364 (21.2% of the Bekaa sheep herd) heads of local *baladi* goats and fat-tailed Awassi sheep respectively (MoA, 2012) both highly adapted to the semi-arid conditions prevailing in the region (Jaber et al., 2004).

2.2. Data collection

Thirty-two small ruminant herds covering 16,700 animals were randomly selected and surveyed in 14 villages of the West Bekaa known for their pastoral activities. Data was collected during single interviews using a pre-tested questionnaire comprising open-ended and closed-ended questions on herd composition and management, feeding strategies and pasture use, farming activities and land tenure, as well as socio-economic status of the farmer. Farmers were also asked about the main changes in their farms (size and mobility of herd, production, source of feed and water, labor and market) and surrounding environment (pastures, climate and natural resources) since their involvement in farming activities, and their perception of key reasons behind these changes. The main challenges in their production system as related to the farm history and environment were also identified.

2.3. Categorization of the small ruminant farming systems in the West Bekaa

A typology of the goats and sheep farming systems in the West Bekaa was determined using a principal component analysis (PCA) followed by a hierarchical cluster analysis (HCA) using IBM SPSS version 22. Six quantitative variables relevant to the categorization were used: surface of rented land (Ha), surface of owned land (Ha), amount of on-farm hay production (%), amount of purchased feed from total needed (%), herd size and contribution of pastures to animals feed (%). Since interviewed farmers did not keep records of their farm finance and were not able to give reliable numbers, the farm capital was excluded from the selected variables. Moreover, sheep and goat ratio was not included as mixed herds only represented 20% of total herds.

2.4. Statistical analysis

Continuous data were analyzed using one-way ANOVA and means separated by LSD.

3. Results

3.1. Identification of small ruminant systems in the West Bekaa

A first PCA was conducted that clearly separated the surveyed farms into four clusters, two of which covered 90.6% of the surveyed farms and the remaining two (about 10%) included three outlier farms and were therefore excluded. The farms included in 90.6% of the first PCA were then subjected to a second PCA and subsequent HCA revealing four semi-sedentary farming systems that were then crossed with the perceptions of farmers within each system (Table 1): landless shepherds, with small herds and access to crop residues in (1); small herds and no access to crop residues in (2); medium sized herds and access to crop residues in (3) and large herds in (4). Herds spent 11-12 months on the pasture. Data from the interviews revealed that between October and March, feeding was the same for all identified systems, as goats relied on natural pastures in the mountainous forests of pine, oak and beech, while sheep were left at the farm. However, goats were daily supplemented during winter with some hay and an average of 1 Kg of concentrate/animal (namely barley) (Table 1). During summer season, herds of all systems except system (2) moved towards the plain to feed on rented crop residues around the village.

Farmers in system (1) were landless shepherds who depended on renting agricultural land to grow vegetables, while farmers of system (2) and (3) planted fruit trees and vegetables on the small lands that they owned. On the other hand, farmers of system (4) who owned 0.15Ha only, rented 0.837Ha in average and produced 40% of their need in hay in addition to vegetables destined for the market.
All systems aimed for milk production as goat milk is well appreciated in the West Bekaa and is transformed into an array of traditional dairy products. Milk sale strategies are represented in Table 2. It is clearly seen that only farmers of system (2) whose farms are within the village, completely relied on direct milk sale, while farmers of systems (1) and (4) sold all their milk to intermediate collectors, and farmers of system (3) practiced both direct and indirect sale.

3.2. Production constraints perceived by the farmers in the West Bekaa

Farmers perceived four main categories of constraints affecting their production with pasture access and quality ranking first (Table 3).
Farmers from all identified systems reported a drastic change in the quality of natural pastures mostly related to the plants abundance and species such as the white and red clovers (*Trifolium sp.*) and wild lentils species (*Lens sp.*) that have been reported to decrease or to be "lost". As per the farmers, this was due to rising temperatures in spring leading to plants drying before shedding seeds. They also reported that their herds' mobility was hindered by the agricultural expansion of orchards and vineyards and the establishment of natural reserves. System (4) was more affected by these changes since it had the largest herds and needed more pastures.

Around 22% of the answers reported production constraints related to climate variability, mainly increased temperatures and droughts, and decreased precipitations. They explained

how these changes have affected pastures productivity as mentioned above, and water availability like springs and rain, pushing them to supply their herds with tractor-pulled water cisterns, especially towards the end of summer, hence adding more cost to their production expenses.

Shepherds surveyed in the West Bekaa, particularly systems 3 and 4, suffered from price fluctuations of milk and feed, as well as from the competitive prices of illegal animal products smuggled through the uncontrolled Lebanese-Syrian borders since spring 2011 when the conflicts in Syria started. Prices of smuggled animals were estimated by the farmers to around 75% and sometimes 50% of the price of local animals.

The economic situation of the farmer's household was perceived as a main condition threatening the sustainability of the farm. Sixty-nine percent of the surveyed farmers reported selling animals during the two years preceding the survey and using the generated cash to cover either feed expenses at the farm level or medical expenses at the household level. Moreover, the high cost of labor was reported by farmers in systems 3 and 4 who needed assistance on their large farms. The lack of interest by the farmers' children was another problem reported by 28% of the farmers who showed no interest in expanding their farms in the absence of successors.

Access to treatment and veterinary services at affordable prices was a major problem stated by the farmers from all systems who reported a number of infectious disease outbreaks. Seventy-two percent of surveyed shepherds complained from the nearly absent support of public veterinary services.

3.3. Adaptation strategies of the West Bekaa farmers to perceived constraints

To cope with the changes affecting their production, and in the absence of a significant support from public authorities, farmers have taken short-term decisive actions mainly related to changes in feeding strategies and herd management (Table 4). In terms of animal feeding, eighty-eight percent of interviewed farmers spent more time on pastures and 67% increased feed supplementation. Only 20% of the farmers in system (1) increased the quantity of barley supplemented to their animals during winter as they were already supplementing each animal with around 1.5Kg per day (Table 1).

Furthermore, farmers reported adaptations related to the herd management. Herd size reduction was the main adaptive strategy taken by farmers as 61% of them decreased their herd size to cope with the listed constraints. Changing the herd movement was also practiced but to a lesser extent mainly because of lack of pastures accessibility and availability.

Table 1

Herd size, land tenure, feeding management and access to crop residues of the semi-sedentary small ruminant systems identified in the West Bekaa.

System	System 1 - landless, small herds and access to crop residues	System 2 - small herds and no access to crop residues	System 3 - medium sized herds and access to crop residues	System 4 - large herds	Significance
Number of farms	5	5	8	11	
Herd size	199±21.82[a]	184±22.49[a]	403±13.12[b]	653±60.05[c]	0
Owned land (Ha)	0.6±0.06	0.71±0.32	0.54±0.26	0.05±0.03	0.42
Rented land (Ha)	0.42±0.23	0.14±0.14	0.6±0.17	0.61±0.17	0.378
Summer pasture	Crop residue	Natural pastures	Crop residue	Crop residue	
Contribution of pastures to feed (%)	55±1.77[a]	62.5±0.79[b]	61±3.01[ab]	58±1.62[ab]	0.148
On-farm hay production (%)	0	0	0	40	
Barley supplementation (kg/head/day)	1.5±0.22[b]	0.7±0.09[a]	1±0.17[a]	1.13±0.11[ab]	0.036

[a,b,c,] Means in the same row with different superscripts are significantly different (P<0.05).

Table 2

Milk sale preference as reported in the survey of the semi-sedentary small ruminant systems identified in the West Bekaa.

	System 1 - landless, small herds and access to crop residues	**System 2 - small herds and no access to crop residues**	**System 3 - medium sized herds and access to crop residues**	**System 4 - large herds**
Milk sold to collector	100%	0%	50%	100%
Direct to clients	0%	50%	50%	0%
Direct to local dairies	0%	50%	0%	0%

Table 3

Production constraints perceived by the farmers in the West Bekaa.

Constraints	System 1 - landless, small herds and access to crop residues	System 2 - small herds and no access to crop residues	System 3 - medium sized herds and access to crop residues	System 4 - large herds	Total answers	
					Number	%
Natural resources and climate						
Pasture access and quality	11	9	18	25	63	24.9
Climate variability (drought and precipitations)	9	10	16	22	57	22.5
Water availability	1	1	1	6	9	3.6
Market and political uncertainties	9	9	23	21	62	24.5
On-farm socio-economic conditions	2	1	16	21	40	15.8
Animal health and access to treatment	4	2	7	9	22	8.7

Table 4

Adaptation strategies to perceived constraints, adopted by small ruminant farmers in the West Bekaa.

Adaption strategies	**% of farmers per system**				**% of total farmers**
	System 1 - landless, small herds and access to crop residues	**System 2 - small herds and no access to crop residues**	**System 3 - medium sized herds and access to crop residues**	**System 4 - large herds**	
Pasture and feed					
Spend more time on pastures	60	100	100	91	88
Increase feed supplementation	20	80	88	82	67
Rent more pasture	40	20	25	9	24
Herd management					
Decrease herd size	60	20	75	91	61
Keep same herd size	40	40	13	0	15
Increase herd size	0	40	13	9	23
Change herd movement	33	60	13	18	31

4. Discussion

4.1. Identification of small ruminant systems in the West Bekaa

The four identified semi-sedentary systems in the West Bekaa can be compared to those described by other studies, in the Bekaa and Northern Lebanon, that ranged between sedentary and semi-sedentary systems differing in their use of rangelands and crop residue (Hamadeh et al., 1996; Hosri and Nehme, 2006). However, the current systems in West Bekaa have a limited mobility as compared to the semi-nomadic and transhumant systems described in the Bekaa by the same authors, more than ten years ago, which brings evidence of the shift of small ruminant farmers to a more sedentary system that has been previously reported by other authors in the MENA (Bistanji et al., 2000; Alary et al., 2016). The four identified systems had their movement limited to the lands surrounding their farms and villages. This mobility limitation was more accentuated in system (2) which could not access un-harvested crops in the plain anymore due to pasture fragmentation. Changes in land use have been also reported in the Northern Bekaa with shrinking rangelands and increasing cultivated surfaces (Hamadeh et al., 1999; Darwich and Faour, 2008). Access to pastures was also hindered by municipal policies and the land tenure system which does not delineate the role of local authorities in managing common lands, and by the inheritance laws that prevents the efficient use of the lands (MoA, 2003).

Although all identified systems had a land ownership of less than the average agricultural land holding size in Lebanon estimated to 1.36Ha (MoA, 2012), they have reported growing vegetables and fruits to diversify their on-farm income and satisfy their household subsistence needs. These findings are in agreement with Hussein and Nelson (1998) according to whom livelihood diversification includes on-farm and off-farm activities in an aim to generate additional income and achieve sustainable livelihoods.

In the absence of shepherds' cooperatives and efficient milk collection centers in the West Bekaa, milk sale strategies varied among the different systems based on the size of the herd, the quantity of produced milk, and practicality of sale organization. In fact, Tsourgiannis et al., (2008) and Napoleone et al., (2015) attributed the choice of milk distribution channels to several factors including the size of the flock, the volume of produced milk, the farm income and debt, the selling price, the speed of payment and loyalty. While the price of cow milk is determined by the Ministry of Agriculture, goat milk price is set by the market (availability and seasonality of milk); it is also determined by its fat content, hygiene and transportation involved. However, since most of the collectors and milk producers do not test the milk, and the small traditional dairies rely on visual and olfactory examination of milk, the whole process of selling and buying milk becomes based on trust. By selling milk directly to consumers and processors, farmers

benefit from a higher price estimated to USD 0.87 per liter as compared to USD 0.76 per liter when sold to the collector. Similarly to other developing countries, goat milk value chain in Lebanon is still underestimated; and unlike developed countries where this sector is organized and market oriented (Duboeuf, 2011), goat dairy products in Lebanon suffer from market marginalization and lack of investment. Hence, the revival of this sector relies on the development of efficient marketing strategies involving quality control systems, rehabilitation of infrastructure and innovation in the production systems such as packaging and labelling (El-Balaa and Marie, 2008).

4.2. Production constraints perceived by the farmers in the West Bekaa

The first constraint noted by the farmers was related to the availability and quality of pastures. According to the farmers, the access to natural pastures was greatly limited by agricultural expansion of orchards and vineyards coupled with the establishment of natural reserves, and the increase in pasture rental fees. Hosri and Nehme (2006) reported that pasture rental is one of the major constraints facing sheep and goats' production especially when added to the feed cost which itself is a major production cost particularly in the Arab world where feed production is limited (Hamadeh, 2014). In our study, system (2) was the least affected by the increasing rental fees of pastures as it had open access to common lands all year-long. Moreover, with respect to the loss in pastoral fodder biodiversity, clovers and lentils in this case, may not be the result of early droughts only, as perceived by the farmers, but also of overgrazing and the breakdown of traditional grazing rights as reported by Hamadeh et al., (2006) in the Bekaa region. It is noteworthy to mention that the situation in the West Bekaa differs from the North of Lebanon where pastures were depleted mostly by Syrian refugees' flocks resulting in competition over pastures between Lebanese and Syrian flocks as reported by the FAO (2014).

Farmers' perception of climatic changes focused on two years (2013 and 2014). Despite their awareness of global climate change affecting their pasture quality, farmers noted that their production was mostly affected by short-term climate variability expressed in good (high precipitations and moderate temperatures) and bad (high temperatures, early dry season and low precipitations) years. In fact, the lowest rate of rainfall (472 mm) during the past decade, compared to an average year, was recorded during 2013-2014 (when the survey was conducted) (Mashghara weather station; personal communication). Concurrently, a decrease of 57% in precipitation in the Bekaa and 40-50% on the national level were noted during the same period (Farajalla, 2015), and a moderate drought has occurred in the middle Bekaa during 2014 (Faour et al., 2015). Irregular rainfall with recurring droughts were listed among the serious problems affecting small ruminant production in semi-arid regions, causing detrimental changes in

the ecosystem of rangelands and affecting water availability (Nefzaoui et al., 2012; World Bank, 2013).

Milk and feed price fluctuation was a main problem in systems with larger flocks. Farmers with smaller herd size were less affected by the market prices since they mostly relied on local marketing of their products. Market structure and conditions are a main challenge for the development of the small ruminant sector in the Mediterranean region (Dubeuf et al., 2016; Hosri et al., 2016) and long-term development strategies should be planned to enhance the marketing of animal products with attention to the safety of the products as explained earlier. However in the current circumstances, more efforts should be placed by the government to monitor the Lebanese-Syrian borders and control the escalating prices of feed as well as the declining value and prices of animals as it has been reported by the FAO (2018).
The shortage of on-farm human and financial resources was reported by 15.8% of the collected answers, across systems, as a main challenge threatening farm sustainability. The lack of interest in agriculture and farming activities by the farmers' children was an important cause for herd size reduction particularly when the farmer was advanced in age or suffered from health problems. Similar trends were observed in other Mediterranean countries like Greece and Morocco where social factors such as the absence of farm successors and the harsh working conditions threatened the continuity of the pastoral sector (Tzanopoulos et al., 2011; Boughalmi et al., 2015). The low level of investment in farming and the absence of policies regulating the sector did not encourage youth to get involved in this field. Valorization of goat and sheep dairy products and innovation in infrastructure, production systems, reproduction etc. were suggested by researchers (Duboeuf, 2011; Toro-Mujica et al., 2015) as a mean to attract investments and to encourage young people to sustain their parents' farm. In the absence of on-farm family labor, surveyed farmers also suffered from the high cost of hired labor (including Syrian labor) which is considered a major economic constraint to the sustainability of pastoral and livestock farming (Hamadeh et al., 1999; Tzanopoulos et al., 2011, Dubeuf, 2011). The financial and economic constraints faced by the farmers are challenging to overcome given the under-development of targeted microfinance services in Lebanon where microcredits are usually allocated by non-governmental organizations. Furthermore, they are not widely promoted and often include strict agreements and short-term rigid payments (Wahidi, 2017) which do not encourage farmers to apply.

In accord with the surveyed farmers' perception, veterinary and health services in Lebanon have been reported to be weak with limited transboundary animal disease surveillance, animal quarantine facilities and registered animal vaccination programs (Curtis et al., 2013). Following the conflict in Syria, Lebanese flocks faced a high risk of

outbreaks of livestock contagious diseases which required a one-time vaccination campaign at the national level as reported by the FAO (2014).

4.3. Adaptation strategies of the West Bekaa farmers to perceived constraints

Adaptation strategies adopted by the different systems mostly involved changes in feeding practices as herds spent more time on pastures and increased their feed supplementations. These findings are consistent with those of Hamadeh et al. (1996) and Hosri and Nehme (2006) who have previously reported a heavy use of natural pastures among herds in the Bekaa valley and North of Lebanon. An increased dependence on feed supplements was also noted as a response to feed shortages during drought seasons when pastures are no longer sufficient (Ben Salem and Smith, 2008; Alary et al., 2016). However, Alary et al. (2016) found that some Bedouins societies in Egypt resorted to supplementing their herds with feed during droughts to prevent destocking, and hence stabilized their herd size. Dependence on supplemental feed is considered as one of the main mutations recorded in pastoral and agro-pastoral societies across the semi-arid Mediterranean (Bourbouze, 2000; Nori et al., 2009). It is worth noting that in the absence of accurate record keeping and feed measurement tools, it is difficult to estimate the exact amount of supplemental feed offered and the actual cost incurred. The farmers may tend to exaggerate the quantities of supplemented barley as well as the costs especially when they know that the survey is being conducted as part of a development project.
Other adaptation strategies mainly centered on herd size and management practices. Adjusting flock size according to available feed resources is a strategy adopted by shepherds around the world (Hamadeh et al., 1996; Alary et al., 2016). The reported reduction of herd size, in all systems except system 2, can be understood as a response to the increased production costs and decreased human and natural resources listed by the farmers. However, the noted increase in herd herd size in system (2) could be attributed to the opportunity that these farmers perceived in purchasing animals at an affordable price, as they stated. This strategy could reflect a short-term response to current conditions or a long-term projected livelihood strategy. This is a reflection of the role of small ruminants as a versatile asset for investment and insurance against emergencies (Hamadeh, 2014). On the other hand, changing herd movement, as an adaptive management strategy, was adopted by fewer farmers since access to new pastures was inhibited by different factors discussed in the previous sections.

Finally, the main constraints that challenge the development of the small ruminant value chain, based on the perception of the farmers in this survey, can be reformulated into three categories i) inadequate policies regulating land use and pasture

management, ii) limited governmental role in border control and market regulations, and iii) lack of veterinary and financial services. Accordingly, addressing these challenges with adequate interventions would constitute an effective development strategy that is likely to meet the support of the farmers. These suggestions are in line with previously proposed supportive interventions by Duboeuf (2011), Hamadeh (2014) and Toro-Mujica et al. (2015). However, it is important to keep in mind, that other production constraints, not mentioned by the surveyed farmers, still exist and constitute important challenges for the development of the small ruminant sector such as poor infrastructure, low productivity and reproductive efficiency, and limited use of technology which still hamper the development of the sector and require adapted interventions.

5. Conclusion

The shift to sedentarism observed in the small ruminant systems in the West Bekaa is consistent with the findings of other studies from the MENA region and around the Mediterranean. The four semi-sedentary small ruminant systems that were identified in the West Bekaa, varied in the size of their herds, the adopted feeding strategies and milk marketing chains. Their perception of change included chronic problems related to the depletion of natural pastures, climate variability and the market volatility, and other emerging challenges related to the Syrian influx to the country. All systems complained from the weak public veterinary services. In addition, systems with large herds perceived challenges differently than systems with smaller herds, and suffered more from market prices and high labor cost. Adaptation strategies such as increasing feed supplementation, and reducing mobility and herd size, under the effect of different factors of change are in agreement with reports from the region. Based on the constraints perceived by the farmers, the sustainability of the small ruminant sector in West Bekaa could be enhanced by more inductive governmental policies covering land tenure and pasture management, market and border regulations and improved financial and animal health services.

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CHAPTER IV: THE LEBANESE KISHK: A TRADITIONAL DAIRY PRODUCT IN A CHANGING LOCAL FOOD SYSTEM

Le Kishk libanais : un produit laitier traditionnel dans un système alimentaire local en mutation

Résumé
Cet article se concentre sur l'analyse de la filière du kishk traditionnel préparé avec du blé et du lait dans deux régions Libanaises, la Béqaa Ouest et le Chouf. Il vise à évaluer la transformation du kishk pour analyser la durabilité de ce produit traditionnel, en particulier sous l'effet de l'évolution de la production de blé et de la disponibilité du lait. Une enquête a été menée au niveau des producteurs du kishk et des producteurs de blé pour identifier les différents systèmes de production en fonction de leur envergure et de leurs pratiques. Les résultats ont montré que la production du kishk avait été soutenue par les femmes rurales dans les zones désignées et n'était pas affectée par les changements survenus dans le secteur du blé, notamment l'introduction de nouvelles variétés de blé ; au contraire, ce produit traditionnel a adopté les nouvelles variétés. En outre, la polyvalence de la recette du kishk préparée à partir de lait de vache, de brebis ou de chèvre rend ce produit laitier résistant aux changements de disponibilité et de source de lait. Cependant, la conservation du kishk traditionnel nécessite des efforts considérables en matière de marketing, de certification et de contrôle de qualité.

Mots clefs : Kishk, Liban, systèmes alimentaires locaux, lait, alimentation durable, système alimentaire traditionnel, blé.

The Lebanese Kishk: a traditional dairy product in a changing local food system

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Abstract

This paper focuses on analyzing the production chain of traditional *kishk* prepared with wheat and milk in two Lebanese regions, the West Bekaa and the Chouf. It aims at assessing *kishk* processing to analyze the sustainability of this traditional product especially under the impact of changing wheat production and milk availability. A survey was conducted at the level of *kishk* producers and wheat farmers to identify the different production systems based on their scale and their practices. Results showed that *kishk* production has been sustained by rural women in the designated areas and was not affected by the changes that have occurred in the wheat sector which included introduction of new wheat varieties; on the contrary, this traditional product has adopted the new varieties. In addition, the versatility of *kishk* recipe prepared from either cow, sheep or goat milk, makes this dairy product resilient to changes in milk availability and sources. However, conserving traditional *kishk* requires substantial efforts in marketing, certification, and quality control.

Keywords: Kishk, Lebanon, local food systems, milk, sustainable food, traditional food system, wheat.

1. Introduction

Traditional food reflects culture, history and lifestyle; however, the world of globalization has been threatening culinary heritage and exposing many of the traditional food to extinction (Trichopoulou et al., 2006). Efforts to sustaining this heritage requires studies to understand the production process, the components and the impacts any change might impose on traditional food and its conservation.

Kishk, a traditional dairy product prepared with *bulgur* (dry cracked wheat) fermented in milk or yogurt, originates from two local products: wheat and milk (Ministry of Agriculture [MoA], 2007). These two components have differently responded, through times, to the various changes to which they were subject to, ranging from political changes on the national and regional levels including agricultural policies, fluctuations in the local and international markets and economy, to climate and social changes. While wheat production has changed in terms of cultivated land surfaces and used seed varieties (Ministry of Environment [MoE], United Nations of Development [UNDP] & Global Environment Facility [GEF], 2016; Lebanese Agricultural Research Institute [LARI], 2014), goat and sheep milk production showed more resilience facing different stressors and was able to maintain its production, however with a shift from a traditional pastoral system to a more sedentary one (Hamadeh et al., 1999; Bistanji et al., 2000).

This wheat and milk based fermented product has been prepared and consumed in Lebanon since the 10th century (Al Ghazi, 2001) mainly in the Bekaa region where wheat is grown then harvested starting June. It is prepared with cow, sheep or goat milk; however, while goat milk gives it a typical acidic (pungent) taste, cow milk is more used to prepare commercial *kishk*. *Kishk* is prepared during summer to serve as a provision for winter time. It is also known in other Arab countries like Syria, Jordan and Egypt with variations in its preparation method (Odunfa & Adeyele, 1985). Nevertheless, the low moisture content and acidic pH of the final product makes it safe against the growth of pathogenic micro-organisms (Hamad & Fields, 1982). Although *kishk* is produced exclusively in rural areas, its consumption is common all over the country and constitutes an important part of the winter diet when consumed as a thick soup containing *Qawarma* (preserved lamb meat) and eaten with bread (Salibi, 1997) as well as in pizza or *man'ousheh* (flat dough with a *kishk*-based topping).

1.1 Wheat production in Lebanon

The yearly consumption of wheat in Lebanon ranges between 400000 to 450000 tons (Harrigan, 2014), of which around one forth is locally produced. The general agricultural census prepared by the Ministry of Agriculture (MoA), the Food and Agriculture Organization (FAO) and the Italian Cooperation in 2012 reports that 70% of the cereals planted in Lebanon is wheat, covering a surface of 29840 ha of which 44% are in the Bekaa (central and West) and only 14% in Baalbeck and Hermel (Northern Bekaa) (MoA & FAO, 2012). Zero percent is reported in Mount Lebanon. The main planted varieties of wheat in Lebanon are soft (23 %) and hard or *durum* wheat (77 %), the latter being used for the local food industry of *bulgur*, *kishk*, *freekeh* (roasted green wheat) and pasta rather than for bread. Between 2012 and 2016, an average of 140 000 tons of wheat were produced; most are processed by the local mills into flour and bran, and the rest are used as cracked whole wheat for local traditional recipes (FAO, 2018; Chalak & Sabra, 2007). Although wheat planted surfaces were increasing over the years, wheat production has declined mainly due to variability of rain and fluctuation of temperatures (MoE, UNDP & GEF, 2016).

1.2 Small ruminant production in Lebanon

Small ruminant production has always been an integral part of the rural communities in Lebanon, contributing to the livelihoods of these communities by securing mainly milk and meat products.

Pastoralism in Lebanon has witnessed several changes throughout the years (Hamadeh et al., 1999; Bistanji et al., 2000); it has endured many pressures such as 1) lack of policies related to pastoralism and land tenure, 2) increasing urbanization at the expense of pastures, 3) decreasing rural population along with a decline in the interest of the new generations to invest in the sector, 4) lack of technical skills for pasture

management coupled with weak government support, 5) climate change with predicted rising temperatures and severe droughts, and 6) political and security situation in the region, 7) uncontrolled borders and market prices. Nonetheless, the system has proved to be resilient, as proven by the recorded numbers of augmenting herds and dairy production (FAO, 2011). Moreover, the national small ruminant herd, composed of the local black goat known as *Baladi* and the indigenous *Awassi* sheep both highly rustic, coupled with the adaptive strategies adopted by the shepherds including herd size modification, feed supplementation and income diversification (Dick et al., 2008) highly contributed to the survival of the pastoral system in the country. Furthermore, according to Roselier (2015), a growth of 76% in caprine dairy production accounting for over 54 million Euros has been recorded in Lebanon in 2014 accompanied with a rising consumer demand for goat dairy products such as *labneh* (strained yogurt), yogurt and different types of fresh and fermented cheeses including *kishk*.

Investigations have been previously undertaken to assess the nutritional composition, microbiological quality, and biophysical and rheological properties of the Lebanese *kishk* (Tamime et al., 1999a; Tamime et al., 1999b; Tamime & O'connor, 1995; Tamime & McNulty, 1999; Salameh et al., 2016). Such studies revealed the importance of the kishk product being highly nutritious characterized by its microbiological safety due to its overall inherent characteristics (Tamime & O'connor, 1995; Tamime & McNulty, 1999; Salameh et al., 2016). However, studies targeting the sustainability of this traditional product, especially under the impact of changing local food systems, are rare. Therefore, this study aims at analyzing the production chain of *kishk* as influenced by the changes in wheat production and milk sources.

2. Materials and Methods

The methodology relies on the value chain analysis (Hellin & Meijer, 2006; Tohmé et al, 2011; Tohmé et al, 2014) of *kishk* from the production of wheat and bulgur to making the *kishk*, while describing the sources of milk, the *kishk* recipe and the marketing channels.

Data was collected through a survey during summer of 2014 in the West Bekaa and Chouf regions known for their *kishk* production and consumption. Two different questionnaires based on open-ended and closed-ended questions related to the production practices and selected socio-economic aspects were developed each including about 30 questions: one for the wheat farmers and one for the *kishk* processors. During the interview the farmers were asked questions regarding their farming practices and origins of wheat landraces. In addition, processors of kishk were asked questions about processing practices and input sources. The questions related to the sustainability of wheat and *kishk* production were inspired from the sustainability indicators of the French model IDEA - Indicateur de Durabilité des Exploitations Agricoles – (Zahm et al., 2008).

In order to achieve a representative sample in the absence of any previously assessed statistical data, a geographical coverage was achieved to the largest extent in each region to avoid any selectivity bias. A total of 63 farmers and processors from the West Bekaa and 40 processors from the Chouf were interviewed. All producers were selected in a snowball sampling or chain sampling since they are sparsely distributed in the regions. Wheat producers representing small and large-scale farms and *kishk* producers were randomly selected with the help of local key informants in each region.

Descriptive statistics for the analysis of collected quantitative and qualitative data were conducted using STATA version 12.

3. Results

3.1 Kishk Production in West Bekaa and Chouf

Kishk in the West Bekaa and Chouf is a traditional hand-craft product and a family activity carried at the household level and lead by the women; however, in some cases (2 in the West Bekaa and 4 in the Chouf), the husband is also involved in the production process. Although *kishk* is usually produced at the household level, five cases of production at a group level were identified within the studied sample (i) three groups of women in the West Bekaa, including two small dairy processing units and one agro-food cooperative, all of them selling directly to consumers; (ii) and two other groups of women working from their homes were identified in the Chouf and procure *kishk* to a retail shop. The average production of *kishk* ranged between 5 kg to 500 kg per year per producer or group of producers. None of the producers was considered solely commercial as they all produced *kishk* for their household consumption in the first place.

3.1.1 Mode of Production of Kishk

Kishk making starts with soaking coarse bulgur in yogurt in a large clay bowl – replaced today with plastic ones – and rubbing the mixture daily for four days, until the bulgur totally absorbs the yogurt. During this time, yogurt is added every day to prevent the *kishk* from drying and salt is gradually added to protect it from mold. “Green” *kishk* is obtained after the mixture is left to ferment for nine days. “Green” *kishk* can either be consumed fresh like “*labneh*” (strained yogurt) or cheese, or conserved in glass jars with olive oil for ulterior use. The final steps of making dry *kishk* consist of spreading the green *kishk* on clean cloth sheets on the rooftop to dry under the summer sun while rubbing it every morning to break it into smaller pieces and make sure it dries well. When it totally dries, it is grounded in the mill into a fine powder and ready to be sold. According to the interviewed producers, rubbing of *kishk* used to be a social event gathering women from the neighborhood to help each other and share stories. This method of processing *kishk* is closer to the one described in Davisdon by Zurayk and Abdul Rahman (2008), compared to other recipes documented by the same authors.

3.1.2 Cost of production and labor involved

Kishk production is a labor-intensive process involving 3 to 5 persons during 20 days over a month approximately and sometimes longer depending on the produced quantity and whether the producers process wheat into bulgur or simply purchase bulgur. The average production per household is 50 kilograms.

Based on the information collected from women processors during the interviews, 2 kilograms of *kishk* processed at the household level costs on average between LBP[19] 22 950 (when yogurt and labneh are purchased ready-made) and LBP 17 500 (when milk is purchased and yogurt and labneh are processed at the household level).

Therefore, the profit ranges between 37 050 LBP and 42 500 LBP per 2 kilograms of *kishk* or LBP 18 525 and LBP 21 250 per kilogram. The average *kishk* processor produces around 50 kilograms per season, thus generating profit between LBP 926 500 and LBP 1 253 750 per season.

Hence, the cost of producing *kishk* depends on the origin of milk, yogurt and bulgur, and varies between LBP 8 745 and LBP 11 475 per kilogram of *kishk* without accounting for labor. The average selling price of one kilogram of *kishk* is LBP 30 000, and the average quantity of *kishk* produced is 50 kilograms per season per household, thus generated revenue ranges between LBP 1 062 750 and LBP 926 250 per season. *Kishk* production shows positive profitability for the different dairy ingredients used and irrespective of their source of procurement.

3.1.3 Marketing and packaging

The marketing of *kishk* relies on direct sales to consumers through kinship and personal contacts upon pre-orders in the same town and/or neighboring towns and in the city. Few processors reported to regularly participate in weekly farmers' market in the capital. *Kishk* is sold in transparent plastic bags or cloth bags with no labelling indicating the used ingredients, the production date or the geographical location and nutritional information. Processors rely on the trust relationship with their clients and are reluctant to invest in extra packaging costs.

3.2. Impacts of Wheat Production and Milk Sources on Kishk Production

3.2.1 Wheat production

Wheat remains a crop commonly planted in the Bekaa in rotation with vegetables and legumes on surfaces ranging between 0.2 and 300 ha, with an average yield of 4580 kg/ha ranging between 1000 kg/ha and 8000 kg/ha, exceeding the average of 3000 kg/ha reported in the latest national census (MOA &FAO, 2012). In the Chouf area, wheat is no longer part of any farming system where traditionally it was a main crop planted on small terraces. The fragmentation of land holdings and the steep topography of terraces which

[19] LBP, the Lebanese Pound, is the currency for Lebanon. Each USD 1 is equivalent to LBP 1 500.

are more adapted to fruit orchards, in addition to the unavailability of suitable harvesting equipment, were the main reason behind the decline of wheat production in the Chouf, and consequently its absence.

During the survey, farmers were asked about the wheat varieties they planted, their common names and source of procurement. Farmers referred to the local wheat grown in their region as "*baladi*", others used more specific names like "*Bekaii*" referring to the Bekaa or brown wheat (*asmar*), "*Salamouneh*" referring to its elongated form, and "*Hawraneh*" referring to the volcanic plateau Hawran in Syria; in addition, some called wheat by their color *ahmar* for brown and *biyadi* for white. These "*baladi*" or local varieties are used for processing the majority of the traditional by-products namely bulgur, kishk and flour for traditional "*saj*" flat bread. Both *durum* wheat (*kasi*) and soft wheat (*tareh*) are planted in the West Bekaa; however, to produce *kishk* and *bulgur*, only *durum* variety is used. Both brown and white wheat are used for processing; white bulgur is mainly used to process *kishk* to give it the light whitish color, as it is more preferred by consumers. Two sources of improved wheat varieties were identified: the Lebanese Agricultural Research Institute (LARI) which provided seeds to around 50% of farmers at subsidized prices, and commercial agricultural suppliers in the area who provided farmers with other varieties different than those supplied by LARI.

However, few farmers reported saving their own seeds from previous years for ulterior use, or even exchanging seeds with relatives and neighboring farmers. These farmers kept seeds for only two seasons before buying new ones. We were unable within the scope of this survey and the covered area to identify producers saving seeds from several years back. Moreover, none of the interviewed farmers referred to saving landrace seeds for their heritage value; they all denoted the high yields of the varieties available at LARI and the market.

While 68% of producers prefer to prepare *kishk* with white bulgur to give the final product a lighter color, the rest use the local wheat (23%) and brown wheat (9%) which gives *kishk* a darker color that is usually preferred by the producers' family for own consumption.

3.2.2 Milk sources

Besides wheat, *kishk* production requires milk and yogurt. While almost all processors in the West Bekaa use goat milk to make kishk, the preference in the Chouf is more towards the use of cow milk or even a blend of goat and cow milk. In few reported cases, "*labneh*" (strained yogurt) is used instead of milk and yogurt, and the end-product considered of high quality is consumed by the processor's family and is not intended for sale.

Milk is either purchased from neighboring farmers or cooperatives or produced at home (Table 1). As for the yogurt (known as *laban*), if used in *kishk* making, it is either

purchased from local farmers and dairies or processed from milk at home. In the West Bekaa, yogurt and milk are mainly purchased from neighboring producers or farmers. Only 18% of processors have their own milk production (from their own farm). The milk used is cow, and goat milk or mixed cow and goat milk. Whereas in the Chouf area, 62% of the processors produce their own yogurt, 38% purchase the yogurt; 52% get their milk from their own livestock and 48% purchase it from neighboring farmers or cooperatives.

Table 1. Source of milk and yogurt used by *kishk* processors in the West Bekaa and Chouf

	Source of milk		**Source of yogurt**	
	Purchased milk	**Milk from own farm**	**Purchased yogurt**	**Yogurt processed at home**
West Bekaa	82%	18%	94.44%	5.56%
Chouf	48%	52%	38%	62%

Yogurt and milk are not transported in refrigerated pick-ups or cars since processors consider that the distances separating them from the milk and yogurt producers are short (few minutes of travel).

The difference in the mode of procuring milk and yogurt between the West Bekaa and the Chouf shows a more farm-localized procurement system in the Chouf than in the West Bekaa as people in the Chouf tend to produce their raw material (milk or yogurt) rather than buying them. However, the procurement system adopted in the West Bekaa might be evidence of strong relationships between the different actors (processors and shepherds/farmers) involved in the *kishk* value-chain.

4. Discussion

4.1 Kishk Production in West Bekaa and Chouf

Sustaining traditional techniques and knowledge is essential in the preservation of the original identity of traditional food (Slow Food, 2013). This was demonstrated in the production of Stilton, a traditional cheese in the countries of Nottinghamshire, Leicestershire and Derbyshire when the use of pastoralized milk instead of raw milk deprived this traditional food from its aromatic richness and traditional identity. Hence, Slow Food is fighting for the reuse of raw milk in the production of Stilton cheese (Slow Food, 2017). So far, *kishk* has been preserved in its traditional way of production by the small-scale producers.

In addition, as this study reveals, *kishk* production is profitable, and *kishk* is highly demanded by the Lebanese population hence giving it an advantage for its preservation. However, marketing channels are not regulated and packaging is poor lacking any kind of labelling (ingredients, the production date, the geographical location and nutritional

information). If marketed appropriately, traditional products could have a significant competitive advantage based on their peculiarity as well as their nutritional and physiological advantages (Boros et al. 2013).
Therefore, building the capacities of *kishk* producers on food safety practices and improving their marketing skills would widen their opportunities not only in preserving a traditional food but also contributing to the livelihoods of the shepherds and producers involved in the value-chain. In addition, collective action has high potentials in addressing the inefficiencies, coordination problems and barriers to market access (Markellova et al., 2009); therefore, organizing agro-food cooperatives is highly recommended to aid *kishk* producers in overcoming challenges constraining access to markets and enticing the new generation to get involved in preserving the traditional food processing.

4.2 Impacts of Changes in Wheat Production and Milk Sources on Kishk

The results of this study revealing that *kishk* is being preferably produced with white bulgur, locally grown wheat and brown wheat agree with Zurayk and Abdul Rahman's (2008) according to whom coarse, soft and white bulgur is mostly used in *kishk production*. Processors have adapted their *kishk* production according to the wheat varieties available in the market. In addition, the fact that *kishk* recipe is already versatile and uses either cow, sheep or goat milk, makes this dairy product more resilient to changes in milk availability and sources.
Among the challenges threatening the conservation of the original identity of traditional food is conserving its raw material. For example, before the intervention of Slow Food, tuma d'fé traditional cheese in the Langhe Cuneesi, Italy was at risk of dying out because its raw ingredient, milk product from Langhe breed sheep, was in danger of extinction (Taylor, 2012). Similarly, in the Peninsular Malaysia, *Ikan masak tanah liat* (clay-baked fish), *opok-opok* (glutinous rice crackers), *pulut kukus dalam periuk kera* (pitcher plant glutinuous rice), and *kebebe* (mashed fruits in bamboo) are traditional dishes that are dying out due to the rarity of raw ingredients such as *the ikan loma* (a freshwater fish) which is close to extinction (Cheah, 2014). As revealed in this study, the *kishk* raw materials, wheat and dairy products, are highly available in Lebanon, and *kishk* identity so far is being preserved by using locally and freshly produced dairy products. Therefore, ensuring the sustainability of small-scale dairy production, and pertaining good connections between livestock breeders and *kishk* producers are essential to ensure the good quality and traditional characteristic of this product. However, concerning the other main raw ingredient, the wheat landraces traditionally used are being replaced by improved hybrid varieties of wheat which might be depriving the food from its original identity and added value. The reproduction of wheat landraces is a vital factor influencing the quality of food (Messa and Sottile 2015). Therefore, investigation and research are vital to identify the producers who are preserving and using wheat landraces in Lebanon at large; saving such varieties plays a major role in in-situ preservation of agro-biodiversity and cultural heritage.

4.3 Conservation of Traditional Kishk

Since *kishk* is highly demanded in urban settings, this fostered the probability for launching into the market commercially produced *kishk* hence misleading consumers and threatening rural production of this traditional food. This is a serious challenge confronting conserving traditional products (Trichopoulou et al., 2006), as supermarket dairy products can deteriorate a region's unique taste of place (Nuwer, 2014). In order to minimize the competitiveness of imitations and industrial production, the standardization and registration of the traditional products such as *kishk* would ensure their sustainability.

Small food producers are the last guarantors ensuring the preservation of an endangered heritage; however, they are seldom capable of competing with multi-national producers. Therefore, certifying the traditional quality of their products is important to obtain the administrative and financial protection that is vital to their commercial sustainability (Billiard, 2017). In Asia, several national initiatives have been implemented towards using labels expressing certification marks or trademarks relevant to the legal regime. Such initiatives result in promoting local produce based on the concept of "One Village One Product" which originated in 1979 in Oita, Japan. This concept is based on a local product or industry characteristic of a certain region and turns it into a nationally and globally accepted one. It has been employed in several Asian countries such as the 'One Barangay, One Product' project in the Philippines, 'Satu Kampung, Satu Produk' initiative in Malaysia, the 'Back to Village' campaign in East Java, Indonesia, and the nationwide 'One Tambon, One Product' initiative in Thailand (Wong & Fernandini, 2011; Zografos, 2007). In addition, Protected Designation of Origin and Protected Geographical Identification systems have been playing an important role in creating a strong regulatory framework across the European Union hence protecting traditional local products from falsification or imitation, and promoting these products among consumers. However, even such systems must always be reconsidered to safeguard their efficiencies for small-scale producers. Small producers across EU for example have been facing difficulties in achieving market recognition and have been incapable of complying with the regulations due to their high costs (Slow Food, 2005).

Therefore, certifying the traditional quality of the *kishk* product would ensure its preservation and would support small-producers. In order to regulate the certification process and safeguard its practicality and effectiveness among small-scale producers, regional entities, from public and/or private sector can be important players in developing a system of quality control, certification, traceability, and labeling. In addition, incurring the production at group level / cooperative level would aid producers in complying with the standards and would facilitate the certification mechanism.

5. Conclusion

Kishk production has been sustained by rural women in the West Bekaa and Chouf and remains highly demanded in rural and urban setting. However, small-scale production of *Kishk* lacks efficient marketing strategies and development of business plans; finding good marketing channels for this authentic product is a challenge and an opportunity at the same time to valorize this product.

Kishk recipe is proved to be flexible accommodating sheep, cow, or goat milk; in addition, local farms are revealed to be maintained and local dairy products to be always available for purchase by *kishk* producers that do not own any farm. Therefore, *kishk* production, till now, has not been affected by changes in the dairy sector. Similarly, *kishk* has not been affected by the changes occurring in wheat production as producers have adapted their *kishk* production according to the wheat varieties available in the market. Further studies are warranted to identify the origins of all wheat varieties specially the possibility of finding the landraces wheat varieties planted by the farmers across Lebanon and to deeply investigate the potential of protecting this traditional food by highlighting its unique identity and by assessing the added value of using landraces to up-grade the *kishk* and give it a traditional specialty value.

The authors presume that up-scaling and up-grading *kishk* production through certification, quality control, and labeling would play a substantial role in preserving this traditional food as well as supporting rural livelihoods in the regions where it is produced and creating a traditional food system that would encourage new generations to invest in.

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Developing strategies for different systems of small ruminant production based on farmers' perceptions of change

Développer des stratégies pour différents systèmes de production de petits ruminants basées sur la perception du changement par les agriculteurs

Résumé

La production de petits ruminants dans la région MENA est soumise à des pressions économiques, environnementales et sociales entraînant des changements majeurs dans les systèmes de production. Cette étude examine la perception de changement chez les petits éleveurs de ruminants de la Bekaa ouest au Liban. Les agriculteurs ont perçu les changements différemment selon le système d'exploitation semi-sédentaire auquel ils appartenaient et leur impact dans leur contexte local. Dans tous les systèmes, les agriculteurs ont perçu les changements dans les ressources naturelles (pâturages et eau) et le climat comme une menace majeure pour leur durabilité et ont signalé des contraintes liées à la santé animale et à la faiblesse des services vétérinaires gouvernementaux. En particulier, les systèmes de grands troupeaux ont été confrontés à la fluctuation des prix du marché et des coûts de la main-d'œuvre. Ils ont donc davantage souffert que les systèmes comportant des groupes de taille petite et moyenne en raison d'incertitudes politiques et de marché. La variation dans la perception du changement par les paysans s'est traduite par des stratégies d'adaptation distinctes, qui impliquent une modification de la taille et de la mobilité des troupeaux, une plus longue période de temps consacrée aux pâturages et l'addition d'aliments aux troupeaux. Nous discutons des possibilités et des contraintes méthodologiques pour inclure les perceptions des agriculteurs dans les processus de planification dans une situation caractérisée par une dispersion des parties prenantes qui poursuivent des stratégies individuelles de manière indépendante et avec une faible coordination au sein du groupe d'agriculteurs analysé. S'il est fondamental d'inclure la perception des agriculteurs dans le processus de planification pour faciliter la formulation de politiques et de programmes acceptés par ceux-ci, la planification réussie de politiques et programmes et de de développement dépend 1) d'une traduction adéquate (en aval) des exigences du cadre à la situation locale, et 2) à la synthèse et à la traduction (ascendante) des perceptions locales de l'incertitude et du changement en propositions conformes à la politique.

Developing strategies for different systems of small ruminant production based on farmers' perceptions of change

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Abstract

Small ruminant production in the MENA region faces economic, environmental and social pressures causing major shifts in the production systems. This study investigates the perception of change of small ruminant farmers in the West Bekaa of Lebanon. Farmers perceived changes differently according to the semi-sedentary farming system they belonged to, and their affectedness in their local context. . In all systems, farmers perceived changes in natural resources (pasture and water) and climate as a main threat to their sustainability and reported constraints related to animal health and weak governmental veterinary services. Particularly systems with large herds were significantly challenged by fluctuation of market prices and labor costs, and thus suffered more than systems with small and medium flocks from market and political uncertainties. The variation in farmers' perception of change was translated into distinct adaptive strategies which involved modification of herd size and movement, spending more time on pastures and supplementing herds with feed. We discuss the methodological possibilities and constraints to include farmers' perceptions into planning processes in a situation that is characterized by dispersed stakeholders who pursue individual strategies independently and with little coordination within the group of farmers analyzed. While it is fundamental to include farmers' perception in the planning process to facilitate the formulation of policies and programs that are accepted by the farmers, the successful planning of development programs and policies depends 1) on an adequate (down-) translation of frame requirements to the local situation, and 2) on the synthesis and (up-)translation of local perceptions of uncertainty and change into policy-conform propositions.

CHAPTER V: INTENSIFICATION AS A SET OF POSSIBLE SCENARIOS FOR THE FUTURE OF AGRO-PASTORALISM: CASE STUDY OF DAIRY SYSTEMS IN THE WEST BEKAA AND CHOUF OF LEBANON[20]

L'intensification comme un ensemble de scénarios possibles pour l'avenir de l'agropastoralisme: étude de cas des systèmes laitiers dans la Bekaa Ouest et le Chouf du Liban

Résumé

Le secteur laitier libanais s'est développé au fil des années pour devenir un acteur clé de l'économie nationale avec un marché de près de 200 millions de dollars américains. Les vaches laitières sont élevées dans des systèmes intensifs et appartiennent à des races exotiques améliorées, principalement Frisonnes, avec une consommation considérable de concentré importé et de fourrages ce qui augmente le coût de production de la ferme. Des millions de dollars ont été investis pour améliorer le secteur en établissant ou en réhabilitant des centres de collecte de lait et des coopératives et en autonomisant les petits producteurs de lait.

Ce chapitre a pour objectif de présenter les systèmes laitiers de la Bekaa Ouest et du Chouf-Aley occidentaux comme un modèle d'intensification pour l'avenir de certains agro-pasteurs, en particulier pour les agneaux d'engraissement et les brebis de réforme, en améliorant la reproduction et les indices de croissance et en développant la production du lait des petits ruminants et la transformation laitière. L'intensification peut être vue comme un processus d'adaptation pour certains détenteurs de petits ruminants aux défis et aux lacunes auxquels ils sont confrontés, notamment en l'absence de politiques réglementant l'utilisation des terres et soutenant les agro-pasteurs. Une typologie des systèmes de production a été appliquée pour identifier les différents types de fermes de bovins laitiers dans la Bekaa Ouest et le Chouf-Aley, comprendre leur structure et leurs pratiques de gestion, discuter de leurs différents défis et mettre en évidence l'importance de la mise en place d'une typologie de ce système pour faciliter la planification de projets et politiques de développement.

Cinq types de systèmes de production laitière ont été identifiés en fonction de leur taille et de leur niveau d'intensification: 1) les grands exploitants ayant une activité laitière, 2) les systèmes laitiers intensifs avec des troupeaux de taille moyenne et de petites exploitations agricoles, 3) les systèmes laitiers intensifs de petite taille, 4) les petits agriculteurs avec un troupeau de taille moyenne et 5) les systèmes de subsistance avec de petits troupeaux de faible production laitière. Selon la perception des agriculteurs et les observations des auteurs, la durabilité de ces systèmes dépend de plusieurs facteurs, notamment les coûts de production élevés, la variabilité climatique qui affecte la production et la qualité des fourrages, le rôle limité du secteur public dans la subvention

[20] This chapter has not been published yet.

de la filière du lait, et surtout les normes d'hygiène faibles à la ferme et lors de la manipulation du lait. La diversification des activités au sein des systèmes agro-pastoraux en plus de l'utilisation de technologies adéquates et adaptées, de la production de fourrage et d'aliments concentrés, de races exotiques hautement productives et du développement des marchés pourrait être des enseignements à tirer du secteur laitier pour l'intensification de l'agropastoralisme. Cependant, l'application de certains de ces processus nécessite soit des investissements importants, soit l'acquisition de terres que la plupart les agro-pasteurs ne peuvent pas se permettre, limitant ainsi l'intensification à ceux qui disposent de ressources suffisantes pour l'adopter.

Mots-clés: bovins laitiers, scenario d'intensification, agropastoralisme, Liban

Intensification as a set of possible scenarios for the future of agro-pastoralism: Case study of dairy systems in the West Bekaa and Chouf of Lebanon

Abstract

The Lebanese dairy sector has grown throughout the years to become a key-player in the national economy with a market of nearly 200 million US dollars. Dairy cows are raised in intensive systems and belong to improved exotic breeds, mainly Friesian, with considerable level of consumption of imported concentrate and forages which increases the production cost of the farm. Millions of dollars have been invested to enhance the sector through establishment or rehabilitation of milk collection centers and cooperatives and empower small-scale milk producers. This chapter aims to present the dairy systems in the West Bekaa and Chouf-Aley as an intensification model for the future of some agro-pastoralists, especially for fattening lambs and culled ewes, improving reproduction and growing indices, developing the production of small ruminants' milk and dairy processing. The intensification can be seen as an adaptation process for some small ruminant holders to the challenges and gaps they are facing, specifically in the absence of policies regulating land use and supporting agro-pastoralists. A farming systems typology was applied to identify the different types of dairy cattle farms in the West Bekaa and Chouf-Aley, understand their structure and management practices, discuss their different challenges and highlight the importance of carrying a farming system typology to facilitate the planning of development projects and policies. Five types of dairy farming systems were identified based on their size and level of intensification: 1) Large-scale farmers with dairy activity, 2) Intensive dairy systems with medium sized herds and small agricultural holdings, 3) Small-scale intensive dairy systems, 4) Small-scale farmers with medium sized herd and 5) Subsistence systems with small herds of low milk production. According to farmers'

perception and the authors' observation, the sustainability of these systems is affected by several factors including high production costs, climate variability altering feed production and quality, limited role of the public sector in subsidizing the dairy value chain, and most of all low hygiene standards at the farm and during handling milk. Diversification of activities within agro-pastoral systems in addition to use of adequate and adapted technologies, forage production and concentrated feed, exotic and highly productive breeds and market development could be lessons to learn from the dairy sector towards the intensification of agro-pastoralism. However, the application of some of these processes requires either high investment or acquisition of land which cannot be afforded by all agro-pastoralists, hence limiting the intensification to only those who have enough resources to adopt it.

Keywords: dairy cattle, scenario of intensification, agro-pastoralism, Lebanon

1. Introduction

This chapter aims to present the dairy systems in the West Bekaa and Chouf as an intensification model for the future of some agro-pastoralists, especially for fattening lambs and culled ewes, improving reproduction and growing indices, developing small ruminants' milk and dairy processing. The intensive cattle farming system in Lebanon, which has evolved throughout the years, could give some insights for adaptation of the small ruminant production system to the challenges and gaps the latter is facing, specifically with the lack of policies regulating land use and supporting agro-pastoralists.

1.1. Brief overview of the Lebanese dairy sector

The Lebanese dairy sector has grown throughout the years to become a key-player in the national economy with a market of nearly 200 million US dollars; however, the country has not yet reached its total yearly production capacity estimated at 160,000 metric tons (Mikhael and Saadeh, 2016). Dairy cows are raised in intensive systems and belong to improved exotic breeds, mainly Friesian, with considerable level of consumption of imported concentrate and forages which increases the production cost of the farm (IFAD, 2017).The history of the dairy sector in Lebanon shows that the sector has always been fragile. As the civil war of 1975 started, the milk collection centers that were established by the Department of Animal Production of the Ministry of Agriculture (MoA) in the 1960's closed, which resulted in a chaotic collection of milk by greedy dealers, leading to food safety problems. At the beginning of the new millennium, IFAD and OPEC co-financed the "Small Livestock farms rehabilitation project" with a budget

of 5.5 million USD, aiming at building 12 collection centers including four in the Bekaa (MoA, 2005). Consequently, milk quality was improved and prices increased; but unfortunately, centers were closed after the project ended and the equipment became property of the state. Three years later, in 2010, the collection centers were leased to the private sector, municipalities and international organizations, after authorization from the Council of Ministers. Hence the quality and price of milk were improved again (Haddad and Chamoun, 2014). The latest (2009-2012) widespread project aiming at rehabilitating the dairy sector was implemented by the FAO and MoA in the Bekaa valley and Hermel-Akkar uplands in the north part of the country (FAO, 2016): Milk collection and cooling centers were rehabilitated and a network of cooperatives was set up to give more power to the farmers in negotiating milk prices. By empowering small-scale milk producers including poor women, and ensuring safe dairy products, the project aimed to build resilient livelihoods for the farmers.

These development projects did not include big dairy companies owned by private groups, which relied on their own resources to improve their production and collect milk.

The fluctuations that have occurred in the dairy sector all through the years, suggest that there is a lack of pre-project assessment, and development programs or policies have been planned and implemented without taking into consideration the different existing farming systems. However, the inefficiency and unsustainability of these programs and policies prove that top down approaches prevent the involvement of key stakeholders – mainly beneficiaries (farmers and processors) – in the planning process and the decision-making (Rached, 2002).

1.2. Intensification of pastoral systems

Pastoral systems across the globe are facing a lot of pressure encompassing rural migration and population decline in rural and mountainous regions, expansion of agriculture and forests on pasture lands, climate variability and climate change, local policies etc. Consequently, as an adaptation to these pressures, intensification has occurred in pastoral systems and which has been reported in Africa (Mortimore and Adams, 1998; Moritz, 2012; Ayantunde et al., 2014) and China (Namgay et al., 2014; Yu et al., 2016) but also in the Mediterranean sheep and goat systems (Papanastasis and Kazaklis, A., 1998).

Moritz (2012) defines pastoral intensification as "a process of increased productivity of animals through capital or labor inputs or technical innovation" with animal productivity being measured in terms of fecundity, milk and/or meat production. Intensification could be of two types:

- In the case of Western Crete in the Mediterranean (Papanastasis and Kazaklis, A., 1998), small ruminant intensification implied livestock restriction to few sites, feed supplementation, use of semi-improved breeds of sheep and goat, and improvement of infrastructure, roads and stables. This consequently resulted in a significant change in land use including under-grazing in some areas and overgrazing in others. Moreover, the intensification process in the small ruminant system was magnified by the EU policies which subsidized farmers and encouraged them to buy more hay and concentrate, and increase the number of animals. On another note, this intensification negatively affected the ecosystem and natural resources through increasing pasture burning (to eliminate woody plants) which consequently accelerated soil degradation. In the case of China, public policies wanting to protect natural pasturelands aimed at encouraging pastoralists to settle down through introducing the use of enclosed pastures and new animal husbandry techniques, encouraging forage plantation and animal feeding and breeding in stalls and restricting livestock grazing (Yu et al., 2016).
- In the case of West African countries, intensification of pastoral systems is not applicable to landless pastoralists but limited to only those who are land tenants and have enough capital to invest in construction of housing and feed purchasing (Moritz, 2012). It usually implicates a shift from small stock to cattle, fodder production to feed the cattle, use of improved breeds and cross-breeds and stall feeding during a part of the year (Moritz, 2012), and integration into agricultural systems (Mortimore and Adams, 1998; Ayantunde et al., 2014).

The objective of the current study is to characterize the different types of family dairy farming systems in two regions of Lebanon the West Bekaa and the Southern part of Mount Lebanon (Chouf and Aley), especially understanding their structure and management practices, discussing their different challenges and highlighting the importance of carrying a farming system typology to facilitate the planning of development projects and policies. In a second step, the study aims to discuss dairy cattle farming systems as a possible model for the future of small ruminant systems. In other words, the small ruminant breeders could learn from the organization and functioning of dairy cattle farming systems and adopt new strategies for their herds

based on integration of crop-livestock practices or improving production per land unit, or valorizing small ruminant products, etc.

2. Methodology

2.1. Study area

The West Bekaa and Chouf-Aley are two adjacent regions separated by the southern part of Mount Lebanon; and while the West Bekaa is characterized by large plains grown with cereals, vegetables and vineyards, the topography of the Chouf is mountainous and terraced agriculture in mainly practiced. Dairy farms in both regions are namely family farms linked to traditional and small-sized processing units, and the whole system suffers from poor planning and poor infrastructure (Asmar, 2011; Haddad and Chamoun, 2014). A study conducted by Hamadeh et al. in 2013 (unpublished) in the Chouf region showed that 45% of interviewed small dairy holders practice animal husbandry as a family tradition complemented with fruits and vegetables production for subsistence. The study also showed that dairy products from small scale dairies and local processors are of low quality standards subsequently causing health risks to the consumers and jeopardizing the sustainability of the small sized dairy farms and "artisanal" processing unit.

2.2. *Survey and data collection*

Data on dairy cattle systems in Lebanon is very scarce, almost non-existent. This study relied on quantitative and qualitative data collected through a survey covering family dairy farms in the West Bekaa and Chouf-Aley. Contacts of farmers were obtained from previous projects and from key informants in both regions. Snowball sampling was also used as interviewed farmers helped identifying and locating other farmers in the region (Goodman, 1961).

A total of 40 dairy farms, 13 in the West Bekaa and 27 in the Chouf, were visited in 22 villages. A questionnaire including open-ended and closed-ended questions was used to collect data related to the structure of the farming system (animal husbandry, crop production, land tenure, equipment, housing), its dynamics (changes in activities and herd size over the past years), herd management (herd composition, feeding, insemination methods, reproduction), marketing of products mainly milk and processing of dairy products. Information on the social status of the farmer (age, educational level, family structure) was also gathered using the same questionnaire. It is worth to mention

that record keeping was done only for cows' calving, and it was difficult to get accurate numbers on the financials of the farm in terms of expenses and profits.

2.3. Farming system typology

In order to better identify and qualify the diverse dairy systems that exist in the West Bekaa and Chouf, we used a typology. Classifying homogenous farms in one group or cluster, called farming systems typology, helps distinguishing different types of farms having the same characteristics and facing similar problems. Hence, farm systems with similar resource bases, crop-livestock production combinations, agricultural and non-agricultural economic activities performed by the farm household members, generated income, and natural, social, infrastructural and institutional resources are classified under one group of farms or farming system (Köbrich et al., 2003; Bertaglia et al., 2007). Moreover, individual farms for which similar development strategies and recommendations are suggested, are also placed under the same farming system type (Köbrich et al., 2003). This typology allows identifying the strengths and weaknesses of the farms under one group and facilitates planning of adequate development strategies and agricultural production programs, implementing efficient policy interventions, effective extension service and transfer of adequate technologies, climate change mitigation, and improved pasture management etc. (Mądry et al., 2008; Vanclay et al., 2005; Alvares Lopez et al., 2008; Chatterjee et al., 2015).

2.4. Data analysis

A 2-stage analysis (Castel et al., 2010) including a principal component analysis (PCA) followed by a hierarchical cluster analysis (HCA) was applied using SPSS version 22. A total of eleven quantitative and qualitative variables distributed over four categories were used to determine the types of farming systems based on the size of the farm, agricultural production, milk production and feed expenses.

Table 2: Categories of used variables

Category	**Variables**
Size of the farm	- Used agricultural land - Number of permanent workers - Number of cows
Agricultural production	- Fruit production - Vegetable production - Forage production
Milk production	- Milk yield (kg/cow/day)

	- Average milk selling price ($/kg) - Milk processing at the farm - Direct sale of milk
Feed expenses	- Feed cost ($/cow/year)

Farm size and the diversification of activities in the farm are two important variables for classifying farms (Castel et al., 2003, Choisis et al., 2012).

Continuous data were analyzed using one-way ANOVA and means separated by LSD.

3. Results

3.1. Dairy farms in the West Bekaa and the Chouf: description of the sample

- Social status of the farmers

All surveyed farms belong to families and are managed by men aged between 24 and 78 years (average age 52) with only 20% younger than 40. Farmers who have children interested in working at the farm represent 37.5% of the total sample; the majority of these farmers have established their farms where they work full-time. Eighty percent of the interviewed farmers descend from families of farmers and are maintaining this family tradition.

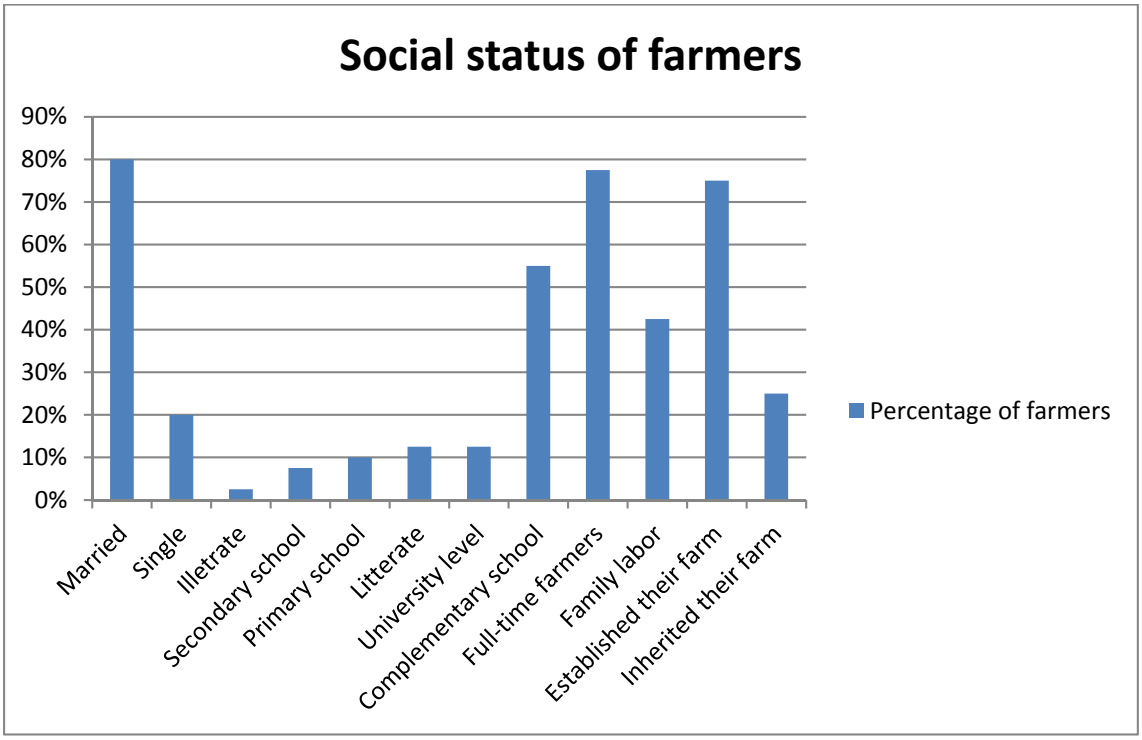

Figure 37: Social status of the farmers surveyed in the West Bekaa and Chouf-Aley

- The farm and herd

In contrast to the small ruminants' production in Lebanon, the traditional dairy cattle sector is independent of natural pastures and cows are kept in stalls most of the time, with access to an open space around the cowshed. Housing in small and medium farms consists of an old concrete room, poorly aerated with concrete feeders and low hygiene standards. Beds often lack mattresses, and when used they are rarely changed. In Aley region, herds (25% of the sample) have access to natural pastures under oak trees in the forests surrounding the farms.

Slurry is released untreated on the lands around the farm and only 6 farmers (15% of the sample) collect slurry in ponds and leave it to dry before selling or using it as organic amendment. Manure is also collected from the farms and incorporated into the farmer's lands (32.5%) or sold to neighbor farmers (25%) at an average of price of 1.88$ per bag of 30 kilos, hence contributing to the farm's income.

Ten percent of the surveyed dairy farms were associated with free range egg production; these farms were in the Shouf and Aley.

The surveyed farms varied in the size of their herds from small farms for subsistence (5 cows in average) to large dairy farms up to 150 cows. Local cow breed and mixed breeds constitute thirty percent of the farms which are usually of small size with less than 15 animals (5.69 animals/ herd). Eight of these farms include small-ruminant production with less than 100 heads of sheep or goats, used to ensure the household needs in meat, milk and dairy products. The remaining 70% of farms are constituted of Holstein breeds.

Sixty seven of the surveyed farmers practice agriculture other than raising cows. While those with small land holdings produce fruits and vegetables mainly for home-consumption, farmers with larger lands produce vegetables and field crops for commercial use and are found in the valley.

- Reproduction and animal health

Sixty percent of farmers use a bull for reproduction and while 71% of them have a reproductive bull on farm, the others use the bull of the neighbors. The reliance on artificial insemination exclusively is limited to only 20% of the farms; another 20% use both natural and artificial insemination methods to reproduce their cows. Drying period of the sample is estimated to 2.33 months and calves are weaned at an average age of 2 months.

Young males are generally sold to a local butcher at a rate of 3.33$/Kg when they reach an average weight of 350Kg and calf fattening is practiced by 37.5% of the farmers.

Main diseases reported by the farmers include cowpox virus (45% of farmers), food and mouth disease (FMD) (12.5%), bovine babesiosis (10%), pneumonia (10%) and Lumpy Skin Disease (LSD) (10%).

- Animal feed and feed production

Farmers depend on outsourced fodder and only six farmers (15% of the sample) produce part of their need in stubble (hay). Herds are generally fed with concentrate (corn, bran, barley, soybean, cotton seeds, wheat, vitamins and salt), stubble (vetch, alfa-alfa, barley and wheat straw) and crop by-products (mainly beet pulp). Only fifteen farmers (37.7%) incorporate silage in their herds' diet. Average feed cost is estimated to 1339$ per cow per year.

- Milk production and processing

Milking cows represent, on average, 63% of the dairy herd and the average milk production is estimated to 17.95±7.40L/cow/day. Only thirty percent of interviewed farmers are members of a dairy cooperative and most of them are in the West Bekaa. These farmers benefit from selling their milk to cooperatives through the milk collector at prices fixed by the cooperatives in agreement with the milk collector (middleman between the farmer and the dairy processing unit or cooperative) and the large dairy plants, but also from attending training and profiting from the distribution of feed and drugs by the Ministry of Agriculture (MoA) which usually works with cooperatives rather than with individual farmers.

Seventy seven percent of the farmers have milking machines and only 32.5% have both cooling tanks and milking machines.

Price of milk depends on the route of sale and vary between 0.6$ when sold through the milk collector or directly to dairy plants and 1.33$ for retail sale to individual clients at the farm. Direct sale of milk is more common in Chouf and Aley where 89% of surveyed farmers sell milk directly, while in the West Bekaa 69% of farmers have individual clients. Sales through a milk collector is practiced the West Bekaa only.

For the 15 farmers who work full-time at their farms, milk sales constitute more than 90% of the farm income. The remaining 10% is covered from sales of manure, calves and crops (if produced).

Table 3: Marketing routes of milk and dairy products

	Retail or direct sale of milk to individual clients	**Milk sale through collector**	**Direct sale of milk to dairy plants**	**Direct sale of milk to individual clients exclusively**	**Sale of dairy products**
Percentage of farmers (%)	85%	17.5%	27.5%	52.5%	35%

Table 4 shows the variation between the surveyed farms in the number of permanent workers (outsourced labor), the size of the agricultural land used by the farmer, and the other variables that were used for the PCA.

Table 4: Quantitative variables used for the PCA

	Minimum	Mean	Maximum
Number of permanent worker	0	0.78±1.05	4.00
Used agricultural land (dunum*)	0	8.35±11.59	41.00
Number of cows	2.00	20.37±27.9	150.00
Milk price ($)	0.60	0.94±0.22	1.33
Milk production (L/cow/day)	5.00	17.95±7.40	35.00
Feed expenses ($/cow/year)	119.05	1339.96±646.09	3109.52

*1 dunum = 0.1 hectare

3.2. Dairy systems identified in the West Bekaa and Chouf-Aley

Four farms with largest herds (56, 60, 100 and 150) were separated by the first PCA and excluded. The remaining 36 farms were subject to a second PCA resulting in three axes accounting for a total variance of 58.13% (Table 5). The "number of permanent workers" and "number of cows" were negatively highly correlated hence the first variable was excluded from the HCA.

Table 5: Contribution of variables to the axes

Axes	Variables	Correlation of variable to axis	Total variance (%)	Cumulative variance (%)
Axis 1	Number of permanent workers Surface of agricultural land Number of cows Milk price Milk production Direct sale	0.761 0.575 0.750 - 0.725 0.494 - 0.665	25.083	25.083
Axis 2	Fruit production Forage production	0.724 0.619	17.388	42.471
Axis 3	Vegetable production Dairy processing Feed cost	- 0.718 0.765 - 0.533	15.661	58.132

Chapter 5: Intensification as a possible scenario for the future of agro-pastoralism: case study of dairy systems in the West Bekaa and Chouf of Lebanon

Five clusters of farms were obtained from the HCA representing five types of farms based on the size of their flock and the quantity of milk produced.

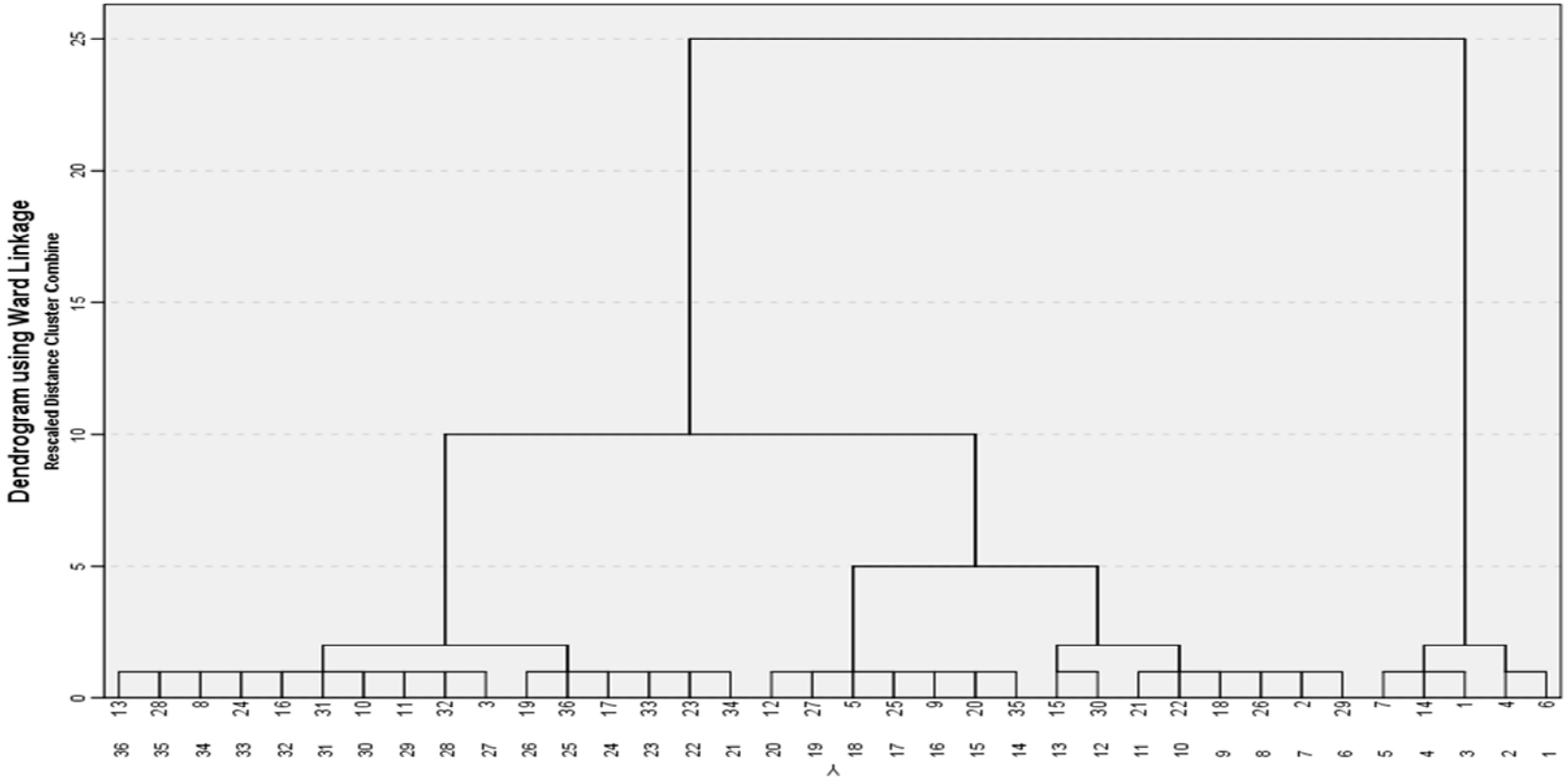

Figure 38: The five family dairy clusters identified by the second PCA in the West Bekaa and Chouf-Aley

Table 6: Dairy systems identified in the West Bekaa and Chouf – Aley

	Cluster1 -	**Cluster2-**	**Cluster3-**	**Cluster4-**	**Cluster5-**	**Significance**
Number of farms	5	8	7	6	10	
Herd Size	5.4±4.97[a]	24.25±2.91[d]	10.14±2.91[b]	15.16±1.17[c]	6.7±2.4[ab]	0.000
Used agricultural land (dn)	33±8.69[b]	3.46±3.64[a]	2.16±1.68[a]	4.5±4.22[a]	1.62±1.97[a]	0.000
Milk yield (L/cow/day)	22.45±5.33[b]	21.16±6.82[b]	25.00±5.09[b]	9.10±3.57[a]	12.07±2.47[a]	0.000
Milk price ($/L)	0.82±0.20	0.97±0.22	0.96±0.23	0.85±0.90	1.11±0.19	0.060
Feed cost ($/cow/year)	1524.19± 605.71	1312.85± 348.51	1726.84± 638.48	1194.56± 1047.43	1273.35± 570.44	0.558

[a,b,c] Means in the same row with different superscripts are significantly different ($P < 0.05$).

1. Large-scale farmers with dairy activity

This system with the largest agricultural lands relies on the production of fruits for commercial use. The small herd (5 on average) consists of the local breed and is milked manually to satisfy the needs of the family with milk and dairy products. The surplus of milk is sold mainly to neighbors and friends but also to small dairy units in the area. Average milk yield per cow is 22.45L/day, representing the high range of the typology.

Farmers in this group are relatively young in age (average age 40 years) and have completed their complementary education. They are fully dedicated to their farms where they live and work without help from their families. Sixty percent of them are not married and none of them have children.

2. Intensive dairy systems with medium sized herds and small agricultural holdings

Farmers in this group own herds of 24 heads in average with small agricultural plots planted either with vegetables or fruits. Half of them sell milk to collectors and 75% sell directly to clients with price ranging between 0.67$ and 1.2$. All herds are of the Holstein breed producing 21.16L/cow/day.

Machine are used for milking and milk is stored either in cooling tanks (50% of farmers in this group) or in buckets. All farms process traditional cheeses and yogurt. Seventy five percent of farmers rely on natural insemination using the neighbors' bull and only 25% adapt artificial insemination conducted by a vet.

All farmers are married, have completed complementary school and work fulltime in their farms which they have established. Seventy five percent of them (all except of two) have a permanent worker helping them at the farm and 50% are assisted by family members.

3. Small-scale intensive dairy systems

This group is characterized with herds of 10 cows in average with the highest milk production (25L/cow/day) among all identified systems. It is found in the West Bekaa and Chouf-Aley where farmers usually produce fruit trees and vegetables for subsistence (85.71% of farmers) on small land plots (2.16dn in average). Forty-two percent of the farms consist of local cow breeds whereas the rest is Holstein probably explaining the relatively high standard deviation in milk yield. More that eighty percent of the farms in this system keep a bull for reproduction, and around half sell their milk exclusively to direct clients while the other half sells milk to large production units. Average feed cost is the highest among the clusters (1726.85$/cow/year) although not statistically significant.

Average age of farmers in this group is 53 years old; they have all established their farms and 71.43% of them are fully dedicated to their farms with no other source of income. Only 42.85% are assisted by family members and half of them have permanent workers.

4. Small-scale farmers with medium sized herd

Farmers in this group have 15 cows in average (Holstein breed) and more than half of them plant fruits and vegetables on small plots of 4.5dn. Labor is ensured by either an outsourced labor or family members. This group is characterized by the lowest milk yield among the other clusters, estimated to 9.1L/cow/day. All farmers have milking machines and a breeding bull.

Average age of farmers is 54 years old, they are all married and half of them have finished university education. 67% are full-time farmers, only 33% work at the farm alone while the others are assisted by either family members or permanent workers.

5. Subsistence systems with small herds of low milk production

This is the largest group that was identified (n=10). Herds are small in size with around 6 cows producing low quantities of milk (12L/cow/day). Land tenures are small with an average 1.62dn where the farm is constructed with an open yard for the animals.

Sixty percent of farmers produce traditional cheese and yogurt and all of them sell milk directly for 1.11$/L (higher than all the other groups but statistically insignificant). Only 40% of the farmers rely on the vet services to inseminate the cows artificially; the others use their bull or the neighbor's. They don't have cooling tanks and only 60% have a milking machine.

Farmers in this group are the oldest (average age 62), all are married with children and 70% of them have at least one of their children involved in the farm activities and interested in sustaining the business. And while only 30% have inherited the farm, the remaining farmers have established the business by themselves.

3.3. Limitations for the sustainability of family dairy farms in the West Bekaa and Chouf-Aley

The sustainability of family dairy farms in the West Bekaa and Chouf-Aley region can be determined by different factors some of which were directly reported by the surveyed farmers when asked about the production challenges they perceive. Other factors affecting the sustainability of the farms were observed during conducting the survey and interviews.

On one side, increased production cost mainly caused by high feed cost is a major challenge that was repeatedly reported by the farmers. Changing weather was another challenge mentioned by the farmers: decreasing precipitation and more frequent droughts resulting in a decline of feed quantity and quality. The limited role of the public sector in subsidizing the dairy

value chain was also a concern for the farmers who were paying for feed, vaccinations and drugs and selling their milk at low rates to the milk collector and dairy factory – case of the Bekaa – in the absence of a well-defined strategy to regulate the milk trade.

On another side, the low hygiene standards in the cowsheds complemented with poor handling of milk in most of the visited farms does not seem to contribute to the sustainability of the farms. The lack of financial record keeping can also impair the efficiency of technical and financial management as well as decision-making. The low rate of involvement in dairy cooperatives is also considered as a factor which withholds the sustainability of the farms. In addition, disposal of organic waste (slurry) directly in the environment would also have some implications on the ecological sustainability of the farm and its surroundings. The last factor that would play an essential role in the durability of these farms is the interest of the farmers' children in farming activities and their ability to sustainably manage the family assets.

Forty three percent of the farmers have decreased their herd size as compared to the previous year. This action has been taken as a response to different forces of change namely high production cost, decreased production of milk, death of animals (calves and cows) due to illness, financial need and farmers' health.

4. Discussion

4.1. Family dairy systems identified in the West Bekaa and Chouf-Aley

Before determining whether the dairy systems in the West Bekaa and Chouf-Aley can serve as a model for intensifying the small ruminant systems, a typification of the existing dairy systems was warranted to understand their structure, functioning, challenges and prospects for sustainability. The identified farming systems are comparable to some of those that were reported by the French Institute of Livestock in 2003 during a study that covered the whole country, specifically the subsistence system with one to three cows having a low milk production of less than 2500Kg/cow/year, the diverse system with medium sized herds of four to six cows associated to the production of vegetables, fruits and field crops, and the intensive

dairy cattle systems with seven and more cows (Institut d'Elevage, 2003). The fourth type that was identified by the French Institute of Livestock is the industrial and semi-industrial dairy farms with and integrated production system which may be similar to the group of farms that were excluded by the first PCA (herds between 50 and 150 cows).

Conditions in small and medium sized farms surveyed in this study are consistent with previous reports (Institut d'Elevage, 2003; Asmar, 2011) in terms of poor infrastructure with low quality standards jeopardizing the quality of milk. All identified systems used natural insemination to reproduce their cows. Artificial insemination service is poor in Lebanon and only 12% of farmers use AI on a regular basis, while the majority (60%) depend on the bull and 28% use both methods (Kayouli, 2010). The low use of AI can have negative consequences on the herd reproduction (fertility) and productivity (milk) (Asmar, 2010).

Feeding strategies were almost the same in all identified systems and difference in feed cost was insignificant. Feed cost per cow per year was calculated based on the estimates of annual feed costs provided by the farmers in the absence of economic records saved by the latter; the only data kept at the farm was related to reproduction (including date of serving and parturition). Absence of record keeping was also observed in 96% of Turkish dairy cattle farm by Elmaz et al. (2012).

Different feeding strategies were noted between various dairy farming systems in Morocco and Algeria, and were mainly related to the level of consumed concentrates (Srairi and Lyoubi, 2003; Sraïri et al., 2005; Kaouche Adjilane et al., 2015). The previous authors also indicated that the differences in the types of dairy farms are highly due to the farmers' technical feeding skills which also highly affect the economy of the farm and consequently determine its sustainability. According to Yilmaz et al. (2016), feed cost accounted for 86.52% of the farms' variable costs in Turkey.

Milk production between the different identified systems was statistically significant; the lowest milk production recorded in systems 4 and 5 (9.10 and 12.07 liter/cow/day respectively) could be explained by several reasons linked to sanitation and animal health, feed and nutrition (Sraïri and Lyoubi, 2003) and also genetics (Kamleh et al., 2006). Sraïri and Lyoubi (2003) attributed the low milk production (2,472 liter/cow/year) to the limited consumption of concentrates, and intensive milk yield (4,024 liter/cow/year) to a high consumption.

Looking at the milk marketing channels, they vary between the systems but also within each system. Combination of direct and indirect routes of sale could explain the need of farmers' convenience to diversify clients to reach better selling prices and consequently higher income. Exclusive direct sale was observed in the Chouf-Aley region where the milk collector is absent similarly to the small ruminants' milk value chain in the aforementioned region. Milk collectors are middlemen who collect milk from dairy farms at a certain price and sell it at a higher price to processing units and milk plants. These traditional milk middlemen called *hallab* in Arabic can be either independent or assigned by the processing units. Dairy farmers in remote areas usually depend on the *hallab* to collect their milk (Asmar, 2009). In Syria for example, *hallabs* dominate the milk value chain and have great power in negotiating prices with the farmers who strongly depend on them. This high dependence is due to the fact that middlemen collect milk in a timely manner before it is spoiled, and they also provide loans/advances to small producers to purchase feed and other farm needs (IFAD, 2015).

4.2. Production constraints of the dairy systems

Castel et al. (2010) conducted a SWOT analysis identifying the weaknesses and strength of Polish farms, which may explain why certain farms or systems operate better than others. Weaknesses included small farm size and large numbers of workers, while strength included diversification of agrarian activity and acceptable cow productivity. Among the opportunities that were identified was the absence of farmers' cooperatives in the region. Some of the results obtained by Castel et al. (2010) are comparable to those in this study such as integrated

farming systems and good milk production which are the strength of family dairy systems and show a higher potential for sustainability. The identified small farms had an acceptable number of workers compared to their size, and lack of membership in a cooperative for some farmers can contribute to a lower sustainability.

The main production and sustainability limitations that were perceived by the surveyed farmers included climate variability probably caused by climate change which is affecting crop productivity, high production costs mainly related to high cost of feed, and the absence of a public support system offering subsidies and regulating milk prices. In addition, the low hygiene standards applied by small-scale dairy farmers constitute a major risk to the sustainability of these businesses.

The strength of the dairy sector resides in the general organization of the sector in terms of milk processing, cheese production, market channels and promotion. The dairy sector in Lebanon has by far outrun the small ruminant sector particularly in the use of technology and in accessing market.

4.3. Intensification of the agro-pastoral system in Lebanon: suitability or irrelevance?

Despite their limits and constraints, the bovine dairy systems identified in the West Bekaa and Chouf-Aley offer some insights for the intensification of agro-pastoralism in Lebanon as an adaptive response to the major constraints the latter is facing. First of all, crop-livestock integration appears as a key-factor of sustainability and resilience facing the challenges and gaps. Diversified farming systems do not limit the development of pastoral activities, but on the contrary, they strengthen pastoral practices through the production of forages and crop residues for the herds during the dry season. The applicability of this may seem very limited due to restricted access to land and infrastructure for cropping similarly to the African case (Moritz, 2016) and due to the high capital investment needed to build stalls and shelters for animal and purchase feed which entails high dependence on the market (Moritz, 2012; Yu et al., 2016) However, some experiences of collective uses of rangeland and collective land could serve as models for sustainable alternatives (Nyberg et al., 2015, Yu et al., 2016), but would nevertheless need efficient agro-pastoralism policies. Secondly the use of technologies, case of some dairy systems in Lebanon and in several other Mediterranean zones, is evidently

complementing the local knowledge of breeders to improve the herd performances, especially in reproduction and growing indices. Adequate and adapted technologies exist for rangeland and agro-pastoralist systems, and the development of the use of these technologies such as AI, automated milking and cooling tanks for milk transportation etc., above all capacitate the small ruminant farmers and enhance the production of their herds. The use of highly productive exotic breeds like Saanen and Alpine goats is still reluctant in Lebanon due to the high investment that is required for this intensive system, and consequently the number of farms with European breeds is still very low. Thirdly, the use of concentrates in dairy systems which frequently appears too high and has to be more adjusted to the feed requirement of the diverse dairy cattle, can be interesting for many agro-pastoralists through reasonable uses, as for example in fattening lambs and culled ewes before marketing, or even flushing ewes etc. Regarding the dairy value chains in Lebanon, the market for cow milk and dairy products is much more developed and organized than the market for sheep and goat, despite the hygiene gaps. While the dairy value chain owes its prosperity to the several projects of international funds with millions of dollars that were implemented since the sixties, it is until recently that the small ruminant value chain started attracting development funds (ACDI/VOCA, 2008; Mercy Corps, 2014; IFAD, 2017). Although goat and sheep dairy products are still niche products, the demand for these products exceeds the supply which is seasonal (Rahhal, 2018). It is true that they cannot compete with international markets without having an added-value, but the objective is not necessary to compete with the leaders of the market as Pr. Ruijin Long from Lanzhou University – China stated in the Chinese short movie, the goal of local production is to access the local market and progressively strengthen its place.

5. Conclusion

The dairy sector in Lebanon has witnessed a lot of changes over the past four to five decades in order to adapt to the consumers' demand, but still suffers from many constraints that are limiting its performance. The agro-pastoralist systems on the other side have also changed and adapted to the different challenges it has faced – and is still facing – but not in the same level as the bovine dairy sector. The bovine dairy sector offers a lot of opportunities for the agro-pastoralist systems to learn from, and the potential of change could be achieved with some basic mechanisms, especially in reproduction performances and feeding particularly for those who can afford the required investment. Nevertheless, the development and application of adequate rangeland policies are still a major issue for the sustainability of extensive small ruminant production in Lebanon, and the prospects for intensification of the sector are not likely to happen in the near future.

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DISCUSSION

CHAPTER VI: RANGELAND CHALLENGES MANAGEMENT: CROSSING AGRO-PASTORALISTS' TALKS AND PERCEPTIONS IN CONTRASTED AREAS

In this chapter, we present an analytical comparison of the perception of agro-pastoralists and livestock farmers in eight contrasted areas around the world: Lebanon, China, Canada, Egypt, Senegal, Uruguay, Brazil and France, in regards to challenges facing their production systems including policies and climate variabilities, as well as to their adaptation strategies and the future of livestock and the involvement of youth in farming activities. This is a more elaborated version of the chapter "Rangeland Challenges Management: Crossing Breeders' Talks and Points of View in Contrasted Areas" that was accepted for publication in the UNESCO book entitled "Specific Environments Global Integrated Management" edited by Luiz Osterbeek.

Gestion des défis liés aux parcours : croisement des discussions et des points de vue des agro-pastoraux dans des zones contrastées

Résumé

Les terres de parcours couvrent une partie considérable des terres émergées dans le monde et couvrent tous les continents, dans les zones tropicales, tempérées et polaires, dans les basses terres et les hautes terres, dans les biomes secs et humides, etc. La végétation des terres de parcours varie en fonction des biomes, des steppes arides à humides, savane arbustive ou avec de grands arbres. Basées sur une forte intégration homme-nature, les sociétés de parcours sont considérées parmi les sociétés les plus en vue du monde. Face aux changements survenus au cours des dernières décennies aux niveaux local et mondial, notre hypothèse est que la survie des parcours, et par conséquent des sociétés de parcours, nécessite des politiques efficaces et spécifiques. L'étude de cas sur le Liban a récemment défini six grandes lacunes et difficultés au niveau des parcours. Ce chapitre analyse la diversité et la généricité de ces lacunes et défis en se basant sur l'interprétation de sept courts métrages tournés dans des zones de parcours contrastées : le plateau tibétain, la grande prairie canadienne, la région bédouine égyptienne, le Sahel sénégalais, la pampa uruguayenne, la Serra Gaucha et la Provence française. Les films présentent logiquement des différences liées aux contextes locaux, mais ils montrent également des similitudes intéressantes entre les différents pays en ce qui concerne

l'importance de politiques spécifiques, l'avenir de la jeunesse et la variabilité climatique. En conclusion, les lacunes et les problèmes signalés dans les sept films sont comparables à ceux identifiés dans l'étude de cas libanaise, en particulier en ce qui concerne la nécessité de politiques spécifiques qui régulent les socio-écosystèmes de parcours et valorisent leur diversité et leurs services essentiels.

Rangeland Challenges Management: Crossing Agro-Pastoralists' Talks and Perceptions in Contrasted Areas

Abstract

Rangelands cover a considerable part of the emerged land in the world and encompass all continents, in tropical, temperate and polar areas, in lowlands and highlands, in dry and humid biomes, etc. Rangeland vegetation varies according to the biomes from arid to humid steppe, small shrub savanna or with high trees. Based on strong human-nature integration, rangeland societies are considered among the most prominent societies in the world. Facing the changes that have occurred over the past decades, at local and global scale, our hypothesis is that the survival of rangelands, and consequently of rangeland societies, requires efficient and specific policies. Six main rangelands gaps and challenges have recently been defined from the Lebanese case study. This chapter analyzes the diversity and genericity of these gaps and challenges based on the interpretation of seven short movies shot in contrasted rangeland areas: the Tibetan Plateau, the Canadian Great Prairie, the Egyptian Bedouin area, the Senegalese Sahel, the Uruguayan Pampa, the Brazilian Serra Gaucha and the French Provence. The movies logically present differences related to local contexts, but they also show interesting similarities between the different countries in terms of the importance of specific policies, the future of youth and climate variability. In conclusion, the gaps and challenges reported in the seven movies are comparable to those identified from the Lebanese case study specifically in regard to the need for specific policies that regulate rangeland socio-ecosystems and valorize their diversity and essential services.

1. Introduction

Rangelands cover around one third[21] of the emerged land in the world, encompassing continents in tropical, temperate and polar areas, in lowlands and highlands, in dry and humid

[21] According to literature the surface of rangelands vary between 18% and 80% of the earth surface - Lund (2007)

biomes. Rangelands vegetation varies according to the biomes, from arid to humid steppe, small shrub savannas or with high trees. Rangelands highly contribute to the well-being of social-ecological systems and offer a wide range of ecosystem services that extend far beyond their boundaries. These services include protection of watersheds, carbon sequestration, reduction of soil erosion and preservation of biodiversity (Lund, 2007; Yahdjian et al., 2015; Hruska et al., 2017). Additionally, rangelands have always been a major source of livelihoods to some of the most famous agro-pastoralists societies in the world such as the Bedouins in the Near East and North Africa (NENA) region, the Fulani in Sub-Saharan Africa, the Gauchos in South America, the Cowboys in North American Far-West and the Mongols and Tibetans in Central Asia etc.

Rangelands are subject to different threats including climate change, overexploitation and land conversion (Lund, 2007; Yahdjian et al., 2015; Hruska et al., 2017) with the latter being strongly linked to urbanization (Greene and Stager, 2001; Yahdjian et al., 2015). The rising demand for recreational services, including hunting and tourism, in addition to agricultural intensification are adding pressure on rangelands and consequently increasing their susceptibility to overuse especially in semi-arid areas (Yahdjian et al., 2015). These factors complemented with inadequate policies that regulate rangelands use and support rangeland users, are causing the degradation of rangelands, consequently resulting in a dilemma at the local and global scales.

Moreover the long-term analysis of diverse rangeland colonization experiences shows the deep and irreversible transformation of rangeland socio-ecosystems, such as the cases in Central Asia (Harris, 2010; Mirzabaev *et al*., 2015) and North Africa (Daoud *et al.*, 2016) with overgrazing and introduction of irrigated systems, in the African Sahel with overgrazing and production of groundnuts (Fall, 2015), in the Cerrado and Pampa in South America (Morales *et al.*, 2016) with the production of soybean, sugarcane, eucalyptus and pines, and in the Great Prairie in North America (Harvey, 2016; Heller, 2017) with irrigated wheat, barley and canola. In some specific cases, the colonization process has led to the desertification of rangelands like in the Argentinean Patagonia in South America (Coronato *et al*., 2016) a century ago, and more recently in the Aral Sea in Central Asia (Coixet, 2010; Synnott, 2015) during the second half of the last century.

Rangelands are an environmental, social and economic entity in which natural and cultural heritage and landscape require the implementation of specific development policies to regulate their use and ensure their sustainability. Therefore, inclusive sustainable local and global development of rangelands appears as one of the main imperatives of the 21st Century.

Based on the Lebanese rangelands case-study reported in chapter 1, six gaps or challenges for rangelands have been identified: i) Lack of specific policies related to pastoralism and land tenure, ii) Urbanization and rural migration, iii) Deforestation and overgrazing, iv) Encroachment by agriculture, v) Lack of technical skills, and vi) Climate variability. This chapter aims at identifying these six challenges in other rangeland areas in the world in order to, on one hand, understand their diversity at a global scale and, on the other hand, help better defining an integrated approach for sustainable local development in rangelands. The gaps and challenges perceived by different breeders in contrasted rangelands around the world are analyzed and compared. These are also crossed to the perception of small-ruminant farmers in Lebanon, reported in chapter 3.

2. Materials & Methods

The Lebanese case-study served as a starting point for the discussion on the rangelands challenges. Seven short movies, 14-18 minutes each, presenting breeders' communities in seven rangeland areas around the world, talking about their families' life and their livestock, were used to document breeders' perception to rangeland challenges and to compare between the different points of view. The discussions in the movies address five main topics which were addressed at different moments in each movie according to their importance to the breeders: i) the local context of rangelands from agro-ecological and socio-economic points of view, ii) the life conditions of the breeders' families, iii) the livestock characteristics and management of the herd and pasture, iv) the debates and conflicts in the rangeland zones, and finally v) the future scenarios of the breeders.

The seven short movies were shot in the following locations: the Qilian Mountains in the north-east of the Tibetan Plateau, China; the Special Areas in the south-west of Alberta Province, Western Canada[22]; The New West Coast Zone, Egypt; the Provence in the Mediterranean Mountains, France; the *Campos de Cima da Serra* in the Serra Gaucha (Atlantic cordillera), Brazil; the Pampa in Uruguay[23]; and the Ferlo Desert in the African Sahel, Senegal[24] (Figure #). Some of the movies (Chinese, French and Egyptian) are not available online yet.

[22] https://www.youtube.com/watch?v=ickPGYg1H3E
[23] https://www.youtube.com/watch?v=W4lBBo89ipM
[24] https://www.youtube.com/watch?v=fx30c9xjbfc

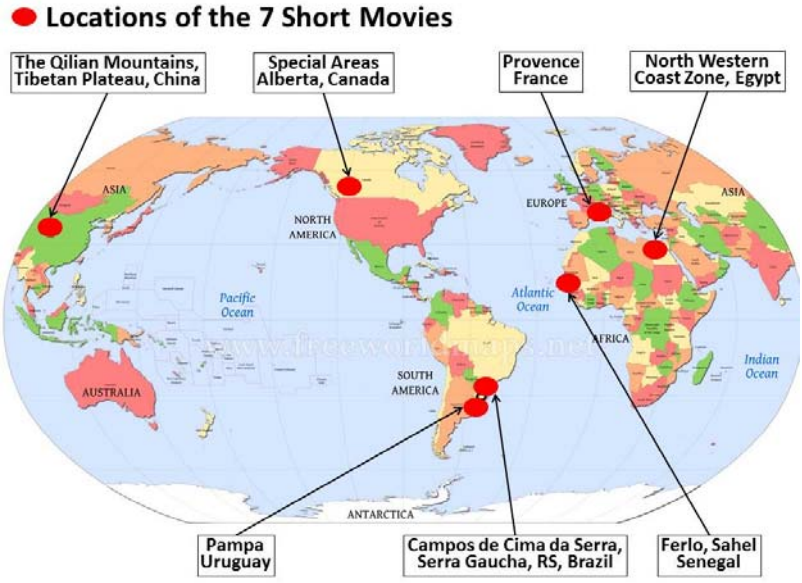

Figure 39: Map of the world showing the different locations where the short movies were filmed

The persons included in the movies vary in age, gender and even profession since not all of them are livestock farmers. While the movie from China shows a typical breeder in the Qilian Mountains of the Tibetan Plateau and a scientist from Lanzhou University, the movie from Uruguay shows two contrasted breeders: a young woman and an old man, from the south and the north of Uruguay respectively. The Egyptian and the French movies feature two typical breeders as well as two local technicians from extension services. The movie from Alberta, Canada shows six breeders and a retired technician sharing their points of view on cattle ranching in the Special Areas. The movie from Brazil was shot during a traditional celebration in the community and focuses on an old couple of farmers. The Senegalese movie shows how Forum Theater was used as a participatory research tool to understand the point of view of agro-pastoral communities and experts on adaptation and transformation facing global changes. The Forum Theater was done in the framework of the *VoiPastorale* Research Project.

The perceptions of rangeland gaps and challenges of breeders and technicians in different areas of the world are analyzed and compared with each other and with those described in the Lebanese case-study. The breeders' adaptation strategies as well as their perception of the future of the young generation in farming are also compared between the different locations.

3. Results

The short movies, except for the Senegalese one, follow more and less the same guideline in presenting the perception of local breeders of challenges and gaps related to rangeland and agro-pastoralism. The content of the short movies has been previously shared and debated (during the LiFLoD project) in the respective communities and validated by different local stakeholders.

3.1. Dependence on natural pastures

In the seven locations of the movies, livestock production strongly depends on natural pastures. The effect of natural pastures on the quality of meat is clearly reported by the Gaucho breeder who highlights the importance of natural pastures to the Uruguayan national meat production, and also by one of the Canadian cattleman who attributes the "excellent" quality of meat to grazing on natural pastures. Concurrently, the farmer in the Tibetan plateau accredits the meat quality of the Tibetan yak and sheep to the local breeding system which also relies on natural pastures. For the African Fulani and French farmers, seasonal migration in quest of available pastures, is essential for livestock production and breeding and depends directly on the weather. As for the Brazilian cattlemen, they consider that natural pastures have been at the basis of their livestock diet for more than three centuries. The Egyptian shepherds and technicians interviewed in the movie explain the strong reliance of livestock production on pastures which depend in their turn on rainfall. Finally, despite the fact that the Canadian ranchers are very aware of the importance and values of native prairies which they preserve by avoiding overgrazing, their concern regarding the sustainability of their farms is linked to the possibility that the government ceases the automatic lease renewal.

3.2. Adaptation to harsh climatic conditions

The breeders also talk about the harsh climatic conditions they are facing in their respective rangeland ecosystems. The Bedouins explain how livestock production systems used to resist to short droughts of 2-3 years by adapting the size of their herds to available feed resources. Nevertheless they cannot estimate the consequences of the current 15-years drought on the medium and long term. They also describe the seasonal herd management practices during dry and rainy seasons and how their dependence on fodder is increasing. In milder conditions, the Gaucho cattlewoman mentions the recent changes in climatic conditions expressed in alternated droughts and heavy raining periods. In another context, the cold winters force the Tibetan and Canadian ranchers to adopt specific and complex feeding practices based on

forage. As for the Fulani pastoralists, and similarly to several other pastoral societies around the world, seasonal migrations are efficient adaptive practices in response to drought and scarcity of feed and water resources.

3.3. The future of livestock and youth in a changing world

In all the movies, the strong attachment of the breeders to their lifestyle is evident regardless of the contexts. The breeders explain how life conditions in rangeland areas have improved over time in terms of infrastructure and roads, electricity and access to phones and internet. Consequently the rural-urban opposition seems less evident than some decades ago. The Gaucho cattleman explains how technology made it possible for labors to work at the farm during the day and ride a motorcycle to return home to their families at night, while in the past they had to spend one or two weeks at the farm and see their families only few days per month. Concomitantly, the Tibetan herder mentions how motorcycles and even cars facilitate nowadays the access to pastures, whereas in the past they used to follow the herd in the pastures on foot. However, despite the progress that has been achieved due to available technologies, the future of the youth in rural areas is still uncertain for several reasons namely lack of schools, absence of health centers and low employment opportunities. The Tibetan farmer clearly states that livestock production is not an option for his son's future; and although he admits that he loves being a herder especially with all the support he receives from the government, he wants his son to pursue his studies at the university and find a better job in the city. The Bedouins, Gauchos and French farmers perceive livestock as part of their children's future only if adequate policies that support livestock farmers and protect rangelands are implemented. In contrast, young people in Canada are fleeing the "crazy urban life" towards rural areas and are investing in cattle ranching. The Canadian case-study, hence confirms the importance of the context and its impact on the farmers' perception of the future and consequently the decisions of the young generation in investing in livestock farming.

3.4. Market access and animal products

The market is strongly present in all the movies; and while it is not mentioned as a priority by the breeders, it is more frequently raised by the technicians and scientists. In the case of the Tibetan Plateau, the scientist emphasizes on the quality of the Tibetan sheep and yack meat, and the need to highlight them as niche products in order to compete with standard beef that is imported from different countries. In the Brazilian movie, the old farmers' couple confirms that although the Serrano cheese they produce is well recognized by urban consumers, they are not able to legally sell it on the market as it does not meet the food safety standards. And while

the Canadian breeders consider that they produce the best meat in the world, the Uruguayan farmer focuses on the successive crisis in the meat market which negatively affects animal production. Finally, one of the sheep farmers in the French movie states that he would rather renounce to the subsidies and have free access to the market.

3.5. Local skills and scientific knowledge

Local skills and scientific knowledge are one of the most complex issues in the movies because of the diverse livestock mental models. The Sahel movie shows different mental models between on one hand policymakers, extension service technicians and breeders' representatives who promote modernism in agro-pastoral production by adopting technologies and, on the other hand, the Fulani people who are still attached to traditional practices such as transhumance which they highly value. This issue represents a main point of conflict that is addressed during the Forum Theater. Brazilian breeders are also attached to traditional practices such as burning pastures to improve the quality of forage, and the Canadian farmers perceive ranching as a lifestyle inherited from grand-parents. However, the Tibetan and French shepherds who also consider livestock farming and pastoralism as a lifestyle, share different stands in regard to the local policies: while the first seems more flexible and has resigned to the environmental policies set by the government, most probably due to the significant subsidies he receives, the others are more critical regarding the diverse environmental and market measures. The difference between local skills and scientific knowledge seems less conflictual in the steppe of South-American Pampa and North-American Great Prairie, probably due to the favorable breeding conditions in these areas.

3.6. Policies

Livestock and rangeland policies are clearly present in the movies although more expressed by the technicians and scientists than by the farmers, probably due to the involvement of the formers in the elaboration and/or implementation of these policies. In the Canadian movie, the ex-manager of Special Areas describes the history of the regional to land tenure policies and how these resulted in preserving native prairies. In the Chinese movie, the scientist describes from one side the public policies aiming at protecting rangelands and subsidizing farmers and from the other side the policies supporting urbanization in an attempt to decrease rural population and consequently livestock numbers. The Tibetan shepherd seems very aware of these policies to which he refers during his talk. Policy measures regarding sheep production are presented in the French movie and both farmers perceive the implemented policies (fire prevention programs) as unsustainable. Additionally, the older farmer expresses his concern

about limitation of pasture land due to urbanization including real estate and tourism projects. In the developing countries, farmers emphasize either on the lack of adequate policies, case of Senegal and Egypt, or the negative impacts of certain policies case of Brazil. Simultaneously, when talking about the reasons of rural exodus, the two Uruguayan farmers criticize the lack of appropriate public policies for rangelands. An additional major problem that has been reported in the Forum Theater by one shepherd is disregarding pastoral societies' points of views by the technicians who often impose on shepherd what to do.

4. **Discussion**

The comparison between the gaps and challenges reported by the farmers and technicians in the movies from one side, and those perceived by the Lebanese small ruminant keepers (Chapter3) in addition to our observation and analysis of the Lebanese case-study (Chapter 4 intro) from the other side, aims to better understand the degree of generality of these gaps and challenges and their variations according to the rangelands context, which will consequently allow the suggestion of scenarios for the future of rangelands and agro-pastoral communities.

4.1. Importance of natural pastures in agro-pastoral systems

It is very clear how important the role of natural pastures is in supporting agro-pastoral systems around the world by providing animal feed in the first place. All farmers agree on the significant contribution of natural pastures to the herds' diet, and they all depend on mobility to seek for new and better pastures to feed their animals. Constraints related to pasture access, use or quality were mentioned by the herder in the Tibetan Plateau where Chinese policies aims at protecting pastures from grazing which forces herders to build enclosures and supplement their animals with feed; the Tibetan herder openly states his preference to grazing to obtain good quality meat rather than feed supplementation. On another hand, the scientist from Lanzhou University explains how the number of animals in the region has drastically increased as compared to thirty years ago, and how the increased animal population has created pressure on the pastures through overgrazing which resulted in the disappearance of important forage grasses. Agro-pastoralists in Lebanon, Egypt and France also perceived degradation in pastures and disappearance of important grazing plants. In all locations, agro-pastoralists are well aware of the effect of climate variability and climate change on natural pastures. Restricted pasture access such as in the West Bekaa of Lebanon, the Tibetan Plateau and French Provence is also a major problem facing agro-pastoralists who find themselves forced to either seek new pastures or decrease the size of their herds or even abandon livestock farming which happened in the Northern Bekaa. Consequently, due to restricted mobility, sedentarism trends are being

observed and have been documented in Lebanon, Egypt and other parts of Africa (Bistanji et al., 2000; Alary et al., 2016).

4.2. Climatic constraints

Climatic constraints, including climate variability, are another challenge that can be generalized to the eight locations, comprising Lebanon. It is obvious that despite the contrasted rangelands in terms of altitude (plain, hill and mountain), latitude (tropical, temperate and pre-polar zones), rainfall (arid, semi-arid and humid areas), and socioeconomic contexts (developing, emerging and developed countries), there are surprising similarities. The reaction of the Bedouins, Fulani, Cowboys and Gauchos are very similar when facing droughts although the intensity of droughts varies from one region to another: In the Egyptian North Sahara, droughts can last for fifteen years with a maximum of 140 mm of annual rainfall; In the Senegalese Sahel and the Canadian Great Plains rainfall is estimated to 250-300 mm during arid years; and in the Uruguayan Pampa rainfall is comparatively higher during dry years with around 600-700 mm. The common strategy of facing drought and sudden adverse climatic conditions, as reported in the movies and in the Lebanese case-study, is adapting feeding management and herd size to the available grazing resources. The question that may rise in this case would be "are Bedouins more used or more resistant to arid weather than the Fulani and Cowboys who could be in their turn more resistant than the Gaucho and the Lebanese shepherds?" Logically, each socio-ecosystem has a livestock system well adapted to its context. The main constraint would then be the unexpected change of this context, the variability of the context outside the normal such as an unforeseen and extreme drought. Consequently, farmers mobilize their factors of resilience which are specific to their societies and contexts such as transhumance, use of feed reserves, purchase of feed, sales of animals, migration to sustain livelihoods and livestock, intra and inter families' solidarity etc.

Furthermore, sudden droughts appear as a relevant driver of change. Agro-pastoralist societies build or find specific mechanisms to face an eventual future climatic event. The difference between the case studies is more related to the resource availability, the production objective and local policies than to the adaptive strategy itself.

4.3. The future of youth and farming

The future of livestock and youth in the eight locations is highly dependent on several factors namely policies that support farmers and encourage young people to stay in the rural areas and invest in livestock production. Other global factors such as climate variability and market prices also play a main role in determining the future. In general, the transmission of livestock

production and pastoralism between generations is breaking under the weight of major forces of change, and young people are hence seeking other opportunities of livelihoods mainly in the cities. As previously reported, parents also contribute to the decision of their children by encouraging them to either stay at the farm and adopt the agro-pastoral lifestyle or to go to the city get an education and find a job. According to Russel (1993), starting in the 80's the interest of youth in admitting to agriculture schools or even in pursuing a career in agriculture and farming has significantly dropped. White (2012) attributed the factors hindering youth from following a farming track to deskilling as a result of academic programs, neglect of agriculture sector and rurality, especially small-scale, in terms of subsidies, financial help, infrastructure, etc. and most importantly accessibility of land for young farmers.

Shalaby et al. (2010) and Ghanem (2014) suggest that effective Agriculture Extension policies and strategies should include youth engagement and training. However, Shucksmith (2010) discusses the paradox development policies where rural development policies that aim at retaining youth in the countryside, may conflict with other youth policies that promote increasing youth opportunities, meaning that it might lead to detaching rural youth from the rural to widen their scope of choices. The sustainability of agriculture in general and livestock and food production in particular relies on young people remaining in rural areas and engaging in agriculture. Knowledge of the lands, traditional artisanal know-how, and cultural heritage are passed on through generations and are under threat if the common trend continues. Moreover, and since the 80's, Fuà (1988) debates different approaches that contribute in making agriculture attractive again to youth. He suggests to change small farms into diversified businesses including for example agro-tourism and food-tourism, that would attract young qualified youths towards agriculture through managerial, marketing, hospitality, and other domains of opportunities directly and indirectly related to agriculture, livestock and rurality. Nevertheless, a debate is launched in the Uruguayan movie "do livestock societies really want young people involved?" This may implicate a significant change in terms of landownership and farm management with new technologies and maybe new relationships with workers and traders and consequently among the new farmers.

4.4. Market access and agro-pastoral products

Valorization of animal products including meat and dairies is essential to penetrate the urban market (case of Brazil) and compete with imports (case of China). Similarly, in Lebanon although the traditional cheese "kishk" was found resilient to drastic changes in its main ingredients, its valorization through possibly a label of quality remains vital in order to sustain its production and introduce it to new markets.

Low-input foods produced in natural environments rather than intensive systems are attracting more consumers who are willing to pay more for quality while supporting local farmers and local productions (Pardini and Nori, 2011). This should pave the way to enhancing the quality of traditional and rural products through establishment of quality-control regulations adapted to small-scale producers who cannot afford the expensive cost of certifications especially in the absence of micro-credits and subsidies.

The suitability of the type of label to propose is strongly related to the local context of each agro-pastoral area including political and institutional contexts as well as an in-depth analysis of the value-chain. Bernard et al. (2014) propose a combination of labels to fit with the different challenges of natural resources conservation, livestock farming development and market opportunities. However, the participation of all actors (stakeholders and shareholders) in the label development process as well as integration of other activities like sustainable tourism for instance is warranted.

4.5. Local skills and scientific knowledge

Other gaps and challenges that are discussed in the movies are also comparable to those described in the Lebanese case study. For example the lack of technical skills or specific rangeland technologies is linked to the weak research developed over the past three to four decades which is mainly due to the lack of rangeland policies especially in developing countries. This also explains the overgrazing and deforestation resulting from mismanagement due to either ignorance or high financial and human investment. Consequently, the low short-term financial return of pastoralism may justify the expansion of urban areas and encroachment of agriculture on rangelands in addition to the low interest of youth in farming.

However the complex situation is mainly the result of disregarding the diverse benefits of rangelands on the medium and long terms, especially their socio-ecosystem services. With the beginning of the new Millennium, Thompson (1997) and more recently Hubert & Ison (2011), showed to rangeland communities, the need for a shift in natural resource management paradigm from the concept of *Resource Sufficiency* to the concept of *Functional Integrity*. Without this shift, the services of natural rangelands, including ecosystem services, cannot compete with agribusiness.

In term of scenarios, the Canadian, Chinese and French case studies show the interest of famers and technicians in social-environmental measures balanced with the economic aspect. However, these measures require long-term and high public investments which so far did not benefit all livestock societies especially in developing countries. Perhaps the implementation of

the current livestock global governance will change the context with a more balanced situation between natural resources management and agribusiness.

4.6. Policies

The last challenge perceived by all farmers, and explicitly stated by the technicians and scientists in the movies, is related to policies adapted to rangeland management and use. Farmers, technicians and scientists from developed countries (Canada, France) and China talk about these policies and, eventually criticize them considering that they could be more appropriate. This is supported by Harris (2010) who describes the Chinese rangeland policies as "conflicting and confusing". According to the interviewed scientist in the Chinese movie, herders are forced to decrease the size of their herds since national policies forbid grazing in certain areas in order to protect them from degradation; however the Chinese government compensates this loss by paying the farmers. Farmers from developing countries including Lebanon suffer either from the lack of specific and adapted policies or their weak or incorrect implementation when they exist. Consequently, the lack of specific rangeland policies or the lack of their implementation is certainly one of the major challenges that face agro-pastoralists and livestock breeders especially in the developing and emerging countries where it directly contributes to the low interest of the youth in livestock production and grazing activities, and consequently threatens the sustainability of the whole sector. In addition to rangeland policies, other factors also contribute to discouraging young people from investing or getting involved in livestock farming specifically; these include the relatively low income and low return vis a vis the high financial investment (land, feed, fence, herd, etc.), the harsh working conditions, weak use of technologies, old-fashioned and outdated connotation of breeding, lack of know-how etc. (Tzanopoulos et al., 2011; Dubeuf et al., 2016). Farmers and agro-pastoralists' should actively participate in planning policies related to pasturelands and their points of view should be taken into consideration, an issue that was highlighted by a herder in the Senegalese movie.

5. Conclusion

Run in different rangelands contrasted in terms of climate-ecology (tropical, temperate and pre-polar zones; plains, mountains and high plateaus; deserts, steppes and savannahs) and socio-economy (developing, emerging and developed countries), the movies present different perspectives related to the local contexts, but they also show similarities specifically related to the need for adequate policies, the challenge of climate variability, and the uncertain future of youth. These challenges reported in the seven movies nearly match the gaps and challenges identified in the Lebanese case-study with some nuances especially regarding the contrasts

between the contexts; the same could be said about the adaptive strategies which are quite comparable between the different locations. As cited in the technicians' talks, specific rangeland policies seems to be the synthetic challenge because it includes the other challenges mentioned in the breeders' words. The lack of awareness among breeders on the various and important ecosystem services of rangelands remains evident. To conclude, it is imperative for successful and efficient policies to involve all stakeholders (including shepherds and farmers) in the developing process and take their perception into consideration.

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CONCLUSION

Agro-pastoral systems around the world are facing similar challenges including climate variability and inadequacy or absence of rangeland policies; consequently, they are developing comparable adaptation strategies such as supplementing herds with feed, diversifying the farm activities, reducing overall herd size and limiting the flock mobility. The comparative study between several rangeland ecosystems, including Lebanon, showed that the implementation of local policies regulating rangeland use and supporting agro-pastoral systems contributes to increasing the sustainability of these systems as well as the rangeland's. Agro-pastoralists around the world share the same perception of change and challenges and their contribution to planning policies and development projects is highly valuable for the efficiency of these policies and projects. Additionally, intensive dairy cattle systems can serve as an intensification model for the future of some agro-pastoralists, especially for fattening lambs and culled ewes, improving reproduction and growing indices, developing small ruminants' milk and dairy processing. The intensification can be seen as an adaptation process for some small ruminant holders to the challenges and gaps they are facing, specifically in the absence of policies regulating land use and supporting agro-pastoralists. However, this intensification process warrants further research to evaluate its impact on the identity of traditional agro-pastoralism. We confirm that the Lebanese case-study is comparable to other rangeland ecosystems in the world and that the reinforcement of adequate policies for rangelands and grazing which also protect the natural ecosystems is crucial for the resilience of agro-pastoral systems facing global changes and for enhancing food security.

ANNEXES

Annex 1: Questionnaire to the small ruminant farmers in the West Bekaa of Lebanon

Nb. of questionnaire:	Caza:	A:	GPS Data:
Town:	Date:	N:	E:

A. Personal info:

1. Farmer's name: [_____]
2. Farmer's gender
   2.1. Female □
   2.2. Male □
3. Year of birth:[_____]
4. Marital status:
   4.1. Single □
   4.2. Married □
   4.3. Widowed □
5. Number of children: [_____]
6. Level of education of the farmer
   6.1. Illiterate □
   6.2. Literate □
   6.3. Primary □
   6.4. Complementary □
   6.5. Secondary □
   6.6. University □
7. Adult children
   7.1. Yes □
   7.2. No □
8. Level of education of the children (if adult)
   8.1. Illiterate □
   8.2. Literate □

8.3. Primary □

8.4. Complementary □

8.5. Secondary □

8.6. University □

9. Are any of the adult children interested in farming? (working at the farm)

9.1. Yes □

9.2. No □

10. Are you a full-time farmer?

10.1. Yes □

10.2. No □

11. Is farming your only source of income?

11.1. Yes □

11.2. No □

12. If not, what is your other source of income? [_____]

13. Who are the beneficiaries of the farm other than the farmer?

13.1. Spouse □

13.2. Children □ 1 12.2.1. How many? □

13.3. Father □

13.4. Mother □

13.5. Brothers/sisters □ 12.5.1. How many? □

13.6. Partners □ 12.6.1. How many? □

14. Total number of beneficiaries: [_____]

B. Labor at the farm

15. Who are the workers at the farm?
    15.1. Wife □
    15.2. Children □
    15.3. Mother □
    15.4. Father □
    15.5. Brothers/sisters □
    15.6. Outsourced labor □
16. Are there permanent workers at the farm?
    16.1. Yes □ 16.1.1. How many? [_____]
    16.2. No □
17. Are there seasonal workers at the farm?
    17.1. Yes □ 17.1.1. How many? [_____]
    17.2. No □

18. Does the farmer keep records? (Including financial, input, output, production etc.)
    18.1. Yes □
    18.2. No □
19. Is the farmer member of a cooperative?
    19.1. Yes □
    19.2. No □
20. If yes, what is the name of the COOP? [_____]
21. If yes to nb. 19, how does the farmer benefit from the COOP?
    21.1. Sales of milk
    21.2. Training and workshops
    21.3. Feed distribution
    21.4. Drugs/vaccines distribution
    21.5. Other; please specify [_____]

C. Farm history and current status

22. Did the farmer establish the farm?
    22.1. Yes □ 19.1.1. What year? [_____]
    22.2. No □
23. Did the farmer inherit the farm?
    23.1. Yes □ 19.1.1. What year? [_____]
    23.2. No □
24. For how long (how many years) has the farmer's family been involved in farming activities? (specifically small ruminants keeping) [_____]
25. For how long (how many years) has the farmer been involved in farming activities? (specifically small ruminants keeping) [_____]
26. General condition of the farm (structure, animal shed, hygiene, etc.)
    26.1. Good; describe: [_____]
    26.2. Bad; describe: [_____]
27. General condition of the animals (hygiene, health etc.)
    27.1. Good; describe: [_____]
    27.2. Bad; describe: [_____]

D. Land tenure and crop-production

28. Total used agricultural land (dn): [_____]
29. Total owned land (dn): [_____]
30. Total rented land (dn): [_____]
31. Is the farmer's house located at the farm?
    31.1. Yes □
    31.2. No □ 31.2.1. How far is the farmer's house from the farm? (km) [_____]
32. Source of water for irrigation: [_____]
33. Does the farmer produce fruits?
    33.1. Yes □ 33.1.1. What type of fruits? [_____]
    33.1.2. Used agricultural surface [_____]
    33.2. No □ (for subsistence)
34. If yes, are fruits produced for commercial purposes?
    34.1. Yes □
    34.2. No □
35. If yes to nb.33, what method of irrigation is used? [_____]
36. Does the farmer produce vegetables?
    36.1. Yes □ 33.1.1. What type of fruits? [_____]
    33.1.2. Used agricultural surface [_____]
    36.2. No □
37. Are vegetables produced for commercial purposes?
    37.1. Yes □
    37.2. No □ (for subsistence)
38. If yes to nb.36, what method of irrigation is used? [_____]
39. Does the farmer produce forage?
    39.1. Yes □ 33.1.1. What type of forage? [_____]
    33.1.2. Used agricultural surface [_____]
    39.2. No □
40. Is forage produced for commercial purposes?
    40.1. Yes □
    40.2. No □ (for herd feed only)
41. If yes to nb.39, what method of irrigation is used? [_____]
42. Does the farmer produce cereals?
    42.1. Yes □ 33.1.1. What type of cereals? [_____]

33.1.2. Used agricultural surface [_____]

42.2. No □

43. Is forage produced for commercial purposes?

43.1. Yes □

43.2. No □ (for subsistence)

44. If yes to nb.42, what method of irrigation is used? [_____]

45. If farmer practices agriculture, fill-in the table below:

Crop	Production (kg/season)	Quantity used for auto consumption	Sold quantities (unit)	Market/clients	Price/unit	Average profit/season

E. Small ruminant production

E.1. Goats

46. Does the farmer keep goats?

46.1. Yes □

46.2. No □ (If no, jump to question nb.???)

47. What is the goat breed? [_____]
48. Total herd size (number of heads): [_____]
49. Number of milking goats: [_____]
50. Number of bucks: [_____]
51. Does the farmer fatten kids?

51.1. Yes □ 51.1.1. Number of fattened kids/season: [_____]

51.2. No □

52. Number of newborn kids/year: [_____]
53. Compared to last year, did the herd size decrease?

53.1. Yes □

53.2. No □

54. If yes, what was the reason?

54.1. Animals death caused by a disease □

54.2. Animals sold □ Why: 54.2.1. High production cost □

54.2.2. High feed cost □

54.2.3. Farmer's health (sick or old – can't take care of the farm)

54.2.4. Farmer needed cash money □
54.2.5. Decreased animal productivity □
54.2.6. Decreased sales of milk □
54.2.7. Other; explain: [_____]

55. If answer to nb.53 is No, explain:
[_____
_____
__]

56. Do you sell male kids?
56.1. Yes □
56.2. No □

57. If yes 57.1. Where? [_____]
57.2. How many per year? [_____]
57.3. For how much? (LBP/Kg) [_____]

58. What is the main source of feed?
58.1. Concentrate □ 58.1.1. What is the concentrate composition?
[_____]
58.1.2. Average quantity offered to the animals? (Kg/head/day)
[_____]
58.2. Hay □ 58.2.1. Average quantity offered to the animals? (Kg/head/day)
[_____]

59. Does the farmer produce feed for is animals?
59.1. Yes □ 59.1.1. How much? (% of total feed)
59.2. No □

60. Does the farmer outsource feed for his animals?
60.1. Yes □ 59.1.1. How much? (% of total feed)
59.1.2. Name the source/suppliers:
[_____]
60.2. No □

Pasture use and grazing routes

Summer pasture	61. Region:	62. Alt:	63. Nature of pasture:	64. Months spent on pasture: 65. Nb of hours spent on pasture:	66. Rent fee (per dn, head, season)
67. What is the contribution of summer pasture to animals' feed?					
68. Do you give supplements during summer? 68.1. Yes □ 68.2. No □ 69. If yes what is the quantity given /head? [_____] 70. Do you supplement all animals? 70.1. Yes □ 70.2. No □					
Winter pasture	71. Region:	72. Alt:	73. Nature of pasture:	74. Months spent on pasture: 75. Nb of hours spent on	76. Rent fee (per dn, head,

				pasture:	season)
77. What is the contribution of winter pasture to animals' feed?					
78. 68. Do you give supplements during summer? 78.1. Yes □ 78.2 . No □ 79. If yes what is the quantity given /head? [_____] 80. Do you supplement all animals? 80.1. Yes □ 80.2. No □					
81. Did you change your grazing routes or pastures? 81.1. Yes □ If yes, explain why and how? 81.2. No □					

E.2. Sheep

82. Does the farmer keep sheep?
82.1. Yes □

82.2. No □ (If no, jump to question nb.???)
83. What is the sheep breed? [_____]
84. Total herd size (number of heads): [_____]
85. Number of milking ewes: [_____]
86. Number of muttons: [_____]
87. Does the farmer fatten lambs?
87.1. Yes □ 51.1.1. Number of fattened lambs/season: [_____]

87.2. No □
88. Number of newborn lambs/year: [_____]
89. Compared to last year, did the herd size decrease?
89.1. Yes □

89.2. No □
90. If yes, what was the reason?
90.1. Animals death caused by a disease □
90.2. Animals sold □ Why: 90.2.1. High production cost □
90.2.2. High feed cost □
90.2.3. Farmer's health (sick or old – can't take care of the farm)
90.2.4. Farmer needed cash money □
90.2.5. Decreased animal productivity □
90.2.6. Decreased sales of milk □
90.2.7. Other; explain: [_____]

91. If answer to nb.53 is No, explain:
[_____
_____]

92. Do you sell male lambs?
92.1. Yes □
92.2. No □

93. If yes 93.1. Where? [_____]
93.2. How many per year? [_____]
93.3. For how much? (LBP/Kg) [_____]
94. What is the main source of feed?
94.1. Concentrate □ 94.1.1. What is the concentrate composition? [_____]
94.1.2. Average quantity offered to the animals? (Kg/head/day) [_____]
94.2. Hay □ 94.2.1. Average quantity offered to the animals? (Kg/head/day) [_____]
95. Does the farmer produce feed for is animals?
95.1. Yes □ 59.1.1. How much? (% of total feed)
95.2. No □
96. Does the farmer outsource feed for his animals?
96.1. Yes □ 96.1.1. How much? (% of total feed)
96.1.2. Name the source/suppliers: [_____]
96.2. No □

Pasture use and grazing routes

Summer pasture	97. Region:	98. Alt:	99. Nature of pasture:	100. Months spent on pasture: 101. Nb of hours spent on pasture:	102. Rent fee (per dn, head, season)
103. What is the contribution of summer pasture to animals' feed?					
104. Do you give supplements during summer? 104.1. Yes □ 104.2. No □ 105. If yes what is the quantity given /head? [_____] 106. Do you supplement all animals? 106.1. Yes □ 106.2. No □					
Winter pasture	107. Region:	108. Alt:	109. Nature of pasture:	110. Months spent on pasture: 111. Nb of hours spent on pasture:	112. Rent fee (per dn, head, season)
113. What is the contribution of winter pasture to animals' feed?					
114. Do you give supplements during summer? 114.1. Yes □ 114.2. No □ 115. If yes what is the quantity given /head? [_____] 116. Do you supplement all animals? 116.1. Yes □ 116.2. No □					

117. Did you change your grazing routes or pastures? 117.1. Yes □ If yes, explain why and how? 117.2. No □

E.3. Manure management

118. What do you do with the manure?
118.1. I sell it □ 118.1.1. To whom? [_____]
118.1.2. For how much? (Price/Bag- weight of bag) [_____]
118.2. I use it on my own land □
118.3. I throw it in the environment □

F. Milk value chain

119. What is the total quantity of milk produced per day? [_____]
120. What is the average quantity of milk produced per animal? [_____]
121. Do you sell milk?
a. Yes □
b. No □
122. If yes, to whom do you sell it?
a. The milk collector 122.a.1.Sold quantity (% of total): [_____]
122.a.2. Average price/L: [_____]
b. A dairy company 122.b.1.Sold quantity (% of total): [_____]
122.b.2. Average price/L: [_____]
c. The cooperative 122.c.1.Sold quantity (% of total): [_____]
122.c.2. Average price/L: [_____]
d. Individual clients (direct sale) 122.d.1. Sold quantity (% of total): [_____]
122.d.2. Average price/L: [_____]
122.d.3. Number of clients: [_____]
123. Does the farmer own a cooling tank?
123.1. Yes □
123.2. No □ 123.2.1. How do you preserve milk? [_____]

124. 1. Does the farmer own a milking machine?
124.1. Yes □
124.2. No □

125. Do you process milk?
125.1. Yes □
125.2. No □

126. If yes, do you sell cheese?
126.1. Yes □
126.2. No □

127. List the dairy products that you process

[_____]

G. Economic info

128. What is the overall house income? [_____]

129. Is there a source of income for the house, other than the farm?
129.1. Yes □ 129.1.1. Explain: [_____]
129.2. No □

130. What is the yearly income of the farm?
[_____]
130.1. Milk sales: [_____]
130.2. Manure sales: [_____]
130.3. Fruits sales: [_____]
130.4. Vegetables sales: [_____]
130.5. Cereals sales: [_____]
130.6. Forage sales: [_____]
130.7. Dairy products sales: [_____]
130.8. Meat/live animals sales: [_____]
130.9. Other: Specify: [_____]

131. What are the overall farm expenses? [_____]
131.1. Feeding cost [_____]
131.2. Fuel/electricity/power: [_____]
131.3. Labor: [_____]
131.4. Vaccines and animal health: [_____]
131.5. Rent of pastures: [_____]
131.6. Rent of farm: [_____]
131.7. Water: [_____]

132. Do you rely on direct help?
132.1. Yes □ If yes, specify: 132.1.1. Ministry of Agriculture □ How:
[_____]
132.1.2. COOP/NGO □ How:
[_____]
132.1.3. Other: Specify: □ How:
[_____]
132.2. No □

H. Farmers' perception to challenges and change

Perceived changes:

133. Since the beginning of your (farmer) involvement in SR farming, have you noticed changes in the pastures?

133.1. Yes □

Please elaborate (explain the reasons behind these changes):
Did these changes affect your farm?
Did these changes affect animal health and behavior?

133.2. No □

134. Since the beginning of your (farmer) involvement in SR farming, have you noticed changes in the weather?

134.1. Yes □

Please elaborate:
Did these changes affect your farm?
Did these changes affect animal health and behavior?

134.2. No □

Perceived challenges

135. What are the main challenges that your production system is facing?

135.1. Pasture access □ ; Explain (if different from Q133):
[_____]
135.2. Pasture quality □ ; ; Explain (if different from Q133):
[_____]
135.3. Increased droughts □ ; Explain (if different from Q134):
[_____]
135.4. Decreased precipitations □ ; Explain (if different from Q134):
[_____]
135.5. Water availability for the animals □ ; Explain:
[_____]
135.6. Emergence of diseases in animals □ ; Explain:
[_____]
135.7. Increased cost of production □ ; Explain:
[_____]
135.8. Marketing problems (sale of milk) □; Explain:
[_____]
135.9. Availability of experienced labor □; Explain:
[_____]
135.10. Access to finance □; Explain:
[_____]
135.11. Farmers' health problems (sick or too old to sustain the farm alone) □
135.12. Lack of support from the family □ ; Explain:
[_____]
135.13. Lack of support from the government (extension service of MoA) □ ; Explain:
[_____]
135.14. Lack of support from the local authority (municipality) □ ; Explain:
[_____]
135.15. Syrian crisis □ ; Explain – competition with Syrian herds on pastures; competition with Syrian dairy products on the market; etc.:
[_____]
135.16. Other: □ ; Explain:
[_____]

I. On-farm changes and adaptation strategies

136. In the past 5-10 years, have you changed the movement of your herd?
136.1. Yes □

Please elaborate:

136.2. No □

137. In the past 5-10 years, did your herd size change?
137.1. Yes □

Please elaborate:

137.2. No □

138. In the past 5-10 years, what were the main changes that occurred in your farm?
138.1. Yes □

Please elaborate:

138.2. No □

139. How did the farmer adapt to the above mentioned challenges?
139.1. Spend more time on pastures □ ; Explain:
[_____]
139.2. Change pasture location □ ; Explain:
[_____]
139.3. Rent additional pastures □ ; Explain:
[_____]
139.4. Decrease herd size □ ; Explain:
[_____]
139.5. Supplement animals with feed □ ; Explain:
[_____]
139.6. Other □ ; Explain:
[_____]

ANNEX 2: Questionnaire for wheat producers and kishk processors

Research title: Value Chain Analysis of Wheat Landraces and Wheat-Based Traditional Foods in Relation to Agrobiodiversity

Nb. of application:……..

Name of enumerator: ……

Location (name of village and neighborhood): ……

Date: ……

Section I: Screening Questions

1. **Are you aged 18 or above?**
    1. Yes
    2. No [THANK AND CLOSE]

2. **Are you owner or tenant of the land you work on?**
    1. Yes, owner
    2. Yes, tenant
        A. System of rent: (1-year, 2-years, seasonally…)_____
    3. No [THANK AND ASK FOR THE OWNER OR TENANT. IF NOT PRESENT, THANK AND CLOSE]

3. **Do you grow wheat on part of, or all, the land?**
    1. Part
    2. All

4. **Do you process kishk and borghol?**
    1. Yes
    2. No

If the answer is “no” to questions 3 and 4, THANK and CLOSE

Section II: Farming Practices and Knowledge (Agro-ecological scale)

1. **Location of farm**
    1. Caza: _____
    2. Village: _____

	[LEAVE BLANK IF NOT KNOWN]
2. How many dunums of arable land do you own?	|_____| dunums
3. How many dunums of arable land do you rent?	|_____| dunums
4. How many dunums of the arable land you own and/or rent that you farm yourself?	|_____| dunums

5. How many dunums of your land (owned and/or rented) are planted with wheat?	|_____| dunums
6. When do you grow wheat? (sesonality)	Summer wheat Winter wheat
7. How many years have you been farming wheat in this region?	|_____| years
8. How many people live in your household?	|_____| people

9. What is the average yield of wheat produced in kg/dunum?
……..

10. During the past 10 years, did you face any drastic changes in any of the following:

1. Yield
2. Prices of wheat
3. Other (labour, land access, input access, water access…) _____

11. For each of the below activities in your wheat production, please answer (1) whether or not you undertake it, and if so, (2) in what amount, and (3) how much you spend on it?

Activity	**1. Yes = 1; No = 2; Don't know/Refuse to answer = 99**	**2. Quantity** [LEAVE BLANK IF NOT KNOWN]	**3. Average amount of money spent** [LEAVE BLANK IF NOT KNOWN]	**4. Labor intensity Number of men and women involved in each activity And Number of days**
A. Seed application	1	|_____| kg per dunum	LBP|_____| per growing season	
B. Irrigation		|_____| times per growing season	LBP|_____| per growing season	
C. Herbicide application		|_____| applications per growing season	LBP|_____| per dunum	
D. Fertilizer application (urea)		|_____| kg per dunum |_____| application/ season	LBP|_____| per growing season Or/ LBP|_____| per dunum	
E. Manure application		|_____| kg per dunum	LBP|_____| per growing season Or/ LBP|_____| per dunum	
F. Tillage		|_____| tractor passes	LBP|_____| per dn	
G. Harvesting		|_____| times per growing season	LBP|_____| per growing season Or/ LBP|_____|	

			per dunum	
H. Pesticide application		|_____| times per growing season |_____| used pesticides	LBP|_____| per growing season Or/ LBP|_____| per dunum	
Mention here types of insect/disease				

12. When you apply pesticides, do you use safety measures:
Gloves….. Mask…… other……

13. If irrigation applies, what is the irrigation system used?
Sprinkler…….. Furrow……. Other…….

14. What is the variety of wheat you are using? (salamouni/breiji wheat (Triticum aestivum), white salamouni, red salamouni, haramouni,)
……

15. What is the common name referred to this variety?(add names)
……

16. Do you grow the same variety every year?
1. Yes. Why? .....
2. No. Why? .....

17. Where do you get it from?
Other farmers…… Research institute …….. Agriculture input suppliers ……. Other…….

18. Do you think it is a local indigenous variety?
1. Yes….
2. No…..

19. Do you know of any farmer who keeps wheat seeds from his ancestors?
1. Yes……. Who? …….Where?
2. No……..

20. What is your production system (typology of farmers):

Annual crops planted	Surface area planted	Yield/year

Perennial crops planted	Surface area planted	Yield/year

Animal diversity: type and race	Number of heads	Type of product (meat, milk, eggs…) and quantity

21. What is the sequence of crops you grow before and after the wheat cultivation?
……

22. Organic matter management: Do you apply manure on wheat?
1. Yes (go to following question)
2. No (move to question 26)

23. What kind of manure do you use?
1. Goat
2. Sheep
3. Cow
4. Other

24. Where do you get the manure from?
1. Your own livestock or small animals
2. Purchase it from same village
3. Purchase it form outside the region

25. Do you use fermented/composted or raw manure?
1. Yes
2. No

26. Do you use any other organic fertilizer? Name it please:
1. Yes: ……..
2. No

27. What do you do with the wheat straw?
1. Sell it. To whom? …….
2. Leave it as mulch in the same wheat field
3. Use it as mulch in other planted fields
4. Feed it to the animals I raise
5. Burn it
6. Other. ……

Section III: Social sustainability

Quality of products:

28. Did you receive any training related to the following in the past 10 years?

	Yes	No	I don't know/ I am not sure
A. Agronomic practices	1	2	99
B. Conservation agriculture	1	2	99
C. Organic agriculture	1	2	99
D. Integrated pest management	1	2	99
E. Safe usage of pesticides	1	2	99
F. Management and Marketing	1	2	99
G. GMP	1	2	99
H. Other	1	2	99

29. Do you have any kind of certification (specify name):

1. Organic: ……
   Name of organization who provided/is providing certificate: …….
2. Fairtrade: ……..
   Name of organization who provided/is providing certificate: …….
3. Quality label: ……..
   Name of organization who provided/is providing certificate: …….

30. Name of organization who provided/is providing certificate: …….

31. Social involvement (tick all what applies):

1. Cooperative member (name of cooperative and location): ……..
2. Takes part in exhibitions, farmers market (specify): ……
3. Direct contact with buyers (who and where): ……..

Contribution to employment:

32. Total number of workers (per dunum of wheat or on all planted surface), gender and age

	[LEAVE BLANK IF NOT KNOWN]	[LEAVE BLANK IF NOT KNOWN]
	Number of workers	Number of days per year
A. Male workers adult/ *over 18 years old*		
B. Male workers under 18 years old		
C. Female workers adult/ *over 18 years old*		
D. Female workers under		

18 years old		

33. Approximately, how many workers assist you with farm operations in the growing season? [LEAVE BLANK IF NOT KNOWN AND SKIP TO next question]

1. |_____| workers

34. Are any of the workers on your farm migrant workers?

1. Yes, all of them
2. Yes, some of them
3. None of them
99. I don't know/ I can't remember

35. What is the approximate daily wage that you pay for the following?

	[LEAVE BLANK IF NOT KNOWN]
E. Male Lebanese workers	LBP|_____| per day
F. Male migrant workers	LBP|_____| per day
G. Female Lebanese workers	LBP|_____| per day
H. Female migrant workers	LBP|_____| per day

36. For how many days per growing season do you require the help of other labourers in wheat growing? [LEAVE BLANK IF NOT KNOWN]

1. |_____| days per growing season

Section IV: Future of the farm

37. What is the surface of wheat you cultivate every year or every other year (compare answer to question II-5)?

……

38. Approximately on what proportion of your land would you plant wheat?

1. Less than 10%
2. Between 10% and 20%
3. Between 20% and 30%
4. Between 30% and 40%
5. Between 40% and 50%
6. Between 50% and 60%
7. Between 60% and 70%
8. Between 70% and 80%
9. Between 80% and 90%
10. More than 90%
99. I don't know

39. **Probable farm sustainability: If the government stops subsidizing wheat**, which statement would now be most appropriate?
    1. I will certainly be producing wheat
    2. I will probably be producing wheat
    3. I hope I will be able to keep producing wheat
    4. I will probably not be producing wheat
    5. I will definitely not be producing wheat
    6. I will try for one year
    99. I don't know

40. **If your answer to the above question is positive, what is the minimum land proportion you will keep under wheat cultivation?** [LEAVE BLANK IF NOT KNOWN] ……

Section V: Socio-economic questions

[INFORM FARMER THAT HE/SHE CAN REFRAIN FROM ANSEWRING ANY QUESTION(S) HE/SHE IS UNCOMFROTABLE ANSWERING]

41. **Gender** _____
42. **Which year were you born?**
    1. 19____
    99. Refuse to answer
43. **Marital status**
    1. Single
    2. Engaged
    3. Married
    4. Widowed
    5. Divorced
    6. Separated
    99. Refuse to answer

44. **Highest level of schooling achieved**

    1. Never Attended
    2. Pre-school
    3. Primary
    4. Intermediate - general
    5. Intermediate - vocational
    6. Secondary – general
    7. Secondary – vocational/technical (BT/LP)
    8. College or University - BSc
    9. College or university – MSc/PhD
    10. Tertiary – vocational/technical (e.g. TS/LT)
    11. Other:_____
    99. I Don't Know/refuse to answer

45. **Do you have employment apart from farming?**
    1. Yes

2. No [Move to question 47]

46. If your answer to above question is Yes (1), what proportion does farming contribute to your income?

1. More than 50%
2. Less than 50%
99. I don't know/ refuse to answer

47. Approximately, what is your total household income per month?

1. Up to 600,000 LBP
2. LBP 600,000 – 1,000,000
3. LBP 1,000,000 – 1,500,000
4. LBP 1,500,000 – 2,000,000
5. LBP 2,000,000 – 2,500,000
6. LBP 2,500,000 – 3,000,000
7. LBP 3,000,000 – 3,500,000
8. LBP 3,500,000 – 4,000,000
9. LBP 4,000,000 – 4,500,000
10. LBP 4,500,000 – 5,000,000
11. LBP 5,000,000 – 5,500,000
12. More than LBP 5,500,000
99. I don't know/ refuse to answer

48. How many household members contribute to the monthly income?.....

49. What is the proportion of household income you get from the different activities:

On-farm activity	Proportion of income (%)	Contribution to income (LBP)
1.		
2.		
3.		
4.		
5.		
6.		
7		
Off-farm activity	Proportion of income (%)	Contribution to income (LBP)
1.		
2.		
3.		
4.		
5.		
6.		
7.		

99. I don't know/ refuse to answer

50. Do you plant wheat for commercial purposes?

1. Yes
2. No

51. What is the proportion of wheat sold to the market:
1. Less than 50%
2. More than 50%
3. 100 %

52. What kind of market do you target?
……
……..

53. What is the proportion of wheat that you process into Kishk or borghol or other bi-products?
1. Less than 50%
2. More than 50%
3. 100 %

Section VI: Wheat bi-products

Questions to be addressed to farmer and/ or to the women producing the bi-products at household level or cooperative level:

Kishk

1. **Do you produce Kishk?**
   1. Yes
   2. No [SKIP to questions on borghol]

2. **Who produces the kishk? (specify which family member(s) is(are) involved in the processing)**
   …….

3. **Where is it produced**
   1. Household level
   2. Cooperative level

4. **Where do you get the wheat from?**
   1. Own land
   2. Neighbors
   3. Shops: where……..
   4. Mills, where:…….
   5. Other: where……..

5. **What variety of wheat is used?**
   1. Common name:……
   2. Other name:…….

6. **What is the quantity of kishk produced?**
   ……

7. During which months of the year do you process the kishk?

.....

8. **Do you use milk or laban to process kishk?**
    1- Milk (if milk go to question 11)
    2- laban (if laban go to question 9, 10 and 11)

9. **What type of laban do you use:**
    1. Goat
    2. Cow
    3. Mixture (proportion of each type of milk):…….
    4. Other (sheep, powder…):……..

10. **How do you source your laban:**
    1- I purchase it from nearby farmers in the region
    2- I purchase it from nearby coop
    3- I make my own (go to question 12 and 13)
    4- Other specify who and where:……..

11. **Distance from laban producers: specify approximate distance in kilometres ……**

12. **What type of milk do you use (this question might be a repetition of question 9 if they purchase the laban):**
    1. Goat
    2. Cow
    3. Mixture (proportion of each type of milk):…….
    4. Other (sheep, powder…):……..

13. **Where do you get the milk from**
    1. I purchase it from nearby farmers in the region
    2. I purchase it from nearby coop
    2. From my own farm
    3. Other: specify who and where:……

14. **Distance from milk producers: specify approximate distance in kilometres** ……
15. **How do you get milk or laban:**
    1. Kind of container, specify (plastic. Aluminium, stainless): …….
    2. Container with lid? Yes No

16. **Transportation to processing unit (**How does it reach your farm, house, or cooperative**)**
    1- In a closed refrigerated pick up
    2- In a closed non-refrigerated pick up
    3- In an open trunk pickup
    4- In a car
    5- Other

17. Processing practices (tick all applicable answers):

1. Boil milk: yes… No…
2. Duration of boiling process in minutes:……..

18. Type of pot used to boil milk

1. Aluminium pot
2. Stainless steel pot
3. Other kind of containers

19. Type of pan/bowl to prepare and mix kishk

1. In plastic
2. In clay
3. Aluminium
4. Stainless
5. Other:……..

20. Where/how does the drying of kishk occurs (tick all relevant answers):

1- Rooftop
2- Garden
3- On cotton sheets
4- On aluminium trays
5- Other:……

21. Sieving of kishk prior to milling (tick all relevant answers):

1- Yes…
2- No….
3- Manually
4- Mechanically

22. Milling of kishk: where do you mill the kishk and how many times:……
……

23. Preservation: what is the kind of container/package you keep the kishk in:

1. Plastic bags
2. Cotton bags
3. Other, specify:……..

24. Where do you keep it?

1- On the floor
2- On shelves
3- Other:…..

Borghol production:

25. Do you produce borghol?

1. Yes
2. No [SKIP all following questions]

26. Who produces the borghol? (specify which family member(s) is(are) involved in the processing)

……

27. Where is it produced

1. Household level
2. Cooperative level (name and location): ……
3. Mill (name and location): ……..
4. Other……

28. Transforming the wheat into borghol: Where is the wheat parboiled?

1. In a kitchen/processing unit
2. On the road/garden

29. Processing practices (tick all applicable answers):

1. Use of stainless steel containers
2. Use of aluminium container
3. Use of cupper container
4. Other

30. Where/how does the drying of wheat take place?

1. Rooftop
2. Garden
3. On cotton sheets
4. On aluminium trays
5. Other:……

31. Do you cover it at night?

1. Yes
2. No

32. Preservation: what is the kind of container/package you keep the borghol in (tick all applicable answers):

1. Plastic bags
2. Cotton bags
3. Barrel plastic
4. Other, specify:……..

33. Where you keep it?

1- On the floor
2- On shelves
3- Other:…..

34. What are the proportions of the two types of borghol you produce:

1. Fine borghol proportion of total borghol produced:…….
2. Coarse borghol proportion of total borghol produced:…….

Other wheat bi-products:

35. Do you produce any other wheat bi-products (freekeh, green kishk, flour,

jreesh…)?……..

Marketing:

36. Marketing of each by-product (tick all applicable answers):

1. Direct sales to consumers in same town
2. Direct sales to consumers in other towns (specify location)
3. Direct sales in farmers market (specify location)
4. Involvement of middle men
5. No middle men
6. Shops (specify location)
7. Other

37. Scale of market:

1. less than 50% of total produced bi-product
2. more than 50% of total produced bi-product

38. Labelling, certification:

1. Yes
2. No

39. Name/type of certification:

……..

That was the last question. Thank you for your help in this research!

ANNEX 3: Survey of family dairy farms in the West Bekaa and Chouf-Aley

Questionnaire

Nb. of questionnaire:	Caza:	A:	GPS Data:
Town:	Date:	N:	E:

A. Personal info:

1. Farmer's name: [_____]
2. Farmer's gender
   2.1.Female □
   2.2.Male □
3. Year of birth:[_____]
4. Marital status:
   4.1.Single □
   4.2.Married □
   4.3.Widowed □
5. Number of children: [_____]
6. Level of education of the farmer
   6.1.Illiterate □
   6.2.Literate □
   6.3.Primary □
   6.4.Complementary □
   6.5.Secondary □
   6.6.University □
7. Adult children
   7.1.Yes □
   7.2.No □
8. Level of education of the children (if adult)
   8.1.Illiterate □
   8.2.Literate □

8.3.Primary □

8.4.Complementary □

8.5.Secondary □

8.6.University □

9. Are any of the adult children interested in farming? (working at the farm)

9.1.Yes □

9.2.No □

10. Are you a full-time farmer?

10.1. Yes □

10.2. No □

11. Is farming your only source of income?

11.1. Yes □

11.2. No □

12. If not, what is your other source of income? [_____]

13. Who are the beneficiaries of the farm other than the farmer?

13.1. Spouse □

13.2. Children □ 1 12.2.1. How many? □

13.3. Father □

13.4. Mother □

13.5. Brothers/sisters □ 12.5.1. How many? □

13.6. Partners □ 12.6.1. How many? □

14. Total number of beneficiaries: [_____]

B. Labor at the farm

15. Who are the workers at the farm?
    15.1. Wife □
    15.2. Children □
    15.3. Mother □
    15.4. Father □
    15.5. Brothers/sisters □
    15.6. Outsourced labor □
16. Are there permanent workers at the farm?
    16.1. Yes □ 16.1.1. How many? [_____]

    16.2. No □

17. Are there seasonal workers at the farm?
    17.1. Yes □ 17.1.1. How many? [_____]
    17.2. No □
18. Does the farmer keep records? (Including financial, input, output, production etc.)
    18.1. Yes □
    18.2. No □
19. Is the farmer member of a cooperative?
    19.1. Yes □
    19.2. No □
20. If yes, what is the name of the COOP? [_____]
21. If yes to nb. 19, how does the farmer benefit from the COOP?
    21.1. Sales of milk
    21.2. Training and workshops
    21.3. Feed distribution
    21.4. Drugs/vaccines distribution
    21.5. Other; please specify [_____]

C. Farm history and status

22. Did the farmer establish the farm?
    22.1. Yes □ 19.1.1. What year? [_____]
    22.2. No □
23. Did the farmer inherit the farm?
    23.1. Yes □ 19.1.1. What year? [_____]
    23.2. No □
24. For how long (how many years) has the farmer's family been involved in farming activities? (specifically small ruminants keeping) [_____]
25. For how long (how many years) has the farmer been involved in farming activities? (specifically small ruminants keeping) [_____]
26. General condition of the farm (structure, animal shed, hygiene, etc.)
    26.1. Good; describe:
    [_____]

26.2. Bad; describe:

[_____]

27. General condition of the animals (hygiene, health etc.)

27.1. Good; describe:

[_____]

27.2. Bad; describe:

[_____]

D. Land tenure and crop-production

28. Total used agricultural land (dn): [_____]

29. Total owned land (dn): [_____]

30. Total rented land (dn): [_____]

31. Is the farmer's house located at the farm?

31.1. Yes □

31.2. No □ 31.2.1. How far is the farmer's house from the farm? (km)

[_____]

32. Source of water for irrigation: [_____]

33. Does the farmer produce fruits?

33.1. Yes □ 33.1.1. What type of fruits? [_____]

33.1.2. Used agricultural surface [_____]

33.2. No □ (for subsistence)

34. If yes, are fruits produced for commercial purposes?

34.1. Yes □

34.2. No □

35. If yes to nb.33, what method of irrigation is used? [_____]

36. Does the farmer produce vegetables?

36.1. Yes □ 33.1.1. What type of fruits? [_____]

33.1.2. Used agricultural surface [_____]

36.2. No □

37. Are vegetables produced for commercial purposes?

37.1. Yes □

37.2. No □ (for subsistence)

38. If yes to nb.36, what method of irrigation is used? [_____]

39. Does the farmer produce forage?

39.1. Yes □ 33.1.1. What type of forage? [_____]

33.1.2. Used agricultural surface [_____]

39.2. No □

40. Is forage produced for commercial purposes?

40.1. Yes □

40.2. No □ (for herd feed only)

41. If yes to nb.39, what method of irrigation is used? [_____]

42. Does the farmer produce cereals?

42.1. Yes □ 33.1.1. What type of cereals? [_____]

33.1.2. Used agricultural surface [_____]

42.2. No □

43. Is forage produced for commercial purposes?

43.1. Yes □

43.2. No □ (for subsistence)

44. If yes to nb.42, what method of irrigation is used? [_____]

45. If farmer practices agriculture, fill-in the table below:

Crop	Production (kg/season)	Quantity used for auto consumption	Sold quantities (unit)	Market/clients	Price/unit	Average profit/season

E. Dairy cattle

46. Does the farmer keep cows?

46.1. Yes □

46.2. No □ (If no, jump to question nb.???)

47. What is the cow breed? [_____]
48. Total herd size (number of heads): [_____]
49. Number of milking cows: [_____]
50. Does the farmer keep a bull for reproduction
50.1. Yes □
50.2. No □
51. Does the farmer fatten calves?
51.1. Yes □ 51.1.1. Number of fattened calves/season: [_____]

51.2. No □
52. Number of newborn calves/year: [_____]
53. Compared to last year, did the herd size decrease?
53.1. Yes □

53.2. No □
54. If yes, what was the reason?
54.1. Animals death caused by a disease □
54.2. Animals sold □ Why: 90.2.1. High production cost □
90.2.2. High feed cost □
90.2.3. Farmer's health (sick or old – can't take care of the farm)
90.2.4. Farmer needed cash money □
90.2.5. Decreased animal productivity □
90.2.6. Decreased sales of milk □
90.2.7. Other; explain: [_____]

91. If answer to nb.53 is No, explain:
[_____
_____
_____]

92. Do you sell male calves?

101.1. Yes □
101.2. No □
102. If yes 102.1. Where? [_____]
102.2. How many per year? [_____]
102.3. For how much? (LBP/Kg) [_____]
102.4. At what age? [_____]
103. At what age are the calves weaned? [_____]
104. How long is the dry period? [_____]
105. What is the main source of feed?
105.1. Concentrate □ 53.1.1. What is the concentrate composition?
[_____]
53.1.2. Average quantity offered to the animals? (Kg/head/day)
[_____]
105.2. Hay □ 53.1.3 Average quantity offered to the animals? (Kg/head/day)

[_____]
106. Does the farmer produce feed for is animals?
106.1. Yes □ 96.1.1. How much? (% of total feed)
106.2. No □
107. Does the farmer outsource feed for his animals?
107.1. Yes □ 97.1.1. How much? (% of total feed)
105.1.2. Name the source/suppliers:
[_____]
107.2. No □
108. What is the adopted insemination method?
108.1. Artificial 106.1.1. Own bull
106.1.2. Neighbor's bull
108.2. Natural

109. What do you do with the manure?
109.1. I sell it □ 107.1.1. To whom?
107.1.2. For how much?
107.2. I use it on my own land □
107.3. I throw it in the environment □

F. Milk value chain

110. What is the total quantity of milk produced per day?
[_____]
111. What is the average quantity of milk produced per animal?
[_____]
112. Do you well milk?
112.1. Yes □
112.2. No □
113. If yes, to whom do you sell it?
113.1. The milk collector 111.1.1.Sold quantity (% of total): [_____]
111.1.2. Average price/L: [_____]
113.2. A dairy company 111.2.1.Sold quantity (% of total): [_____]
111.2.2. Average price/L: [_____]
113.3. The cooperative 111.3.1.Sold quantity (% of total): [_____]
111.3.2. Average price/L: [_____]
111.4. Individual clients (direct sale) 111.4.1. Sold quantity (% of total):
[_____]
111.4.2. Average price/L:
[_____]
111.4.3. Number of clients:
[_____]
112. Does the farmer own a cooling tank?
112.1. Yes □
112.2. No □ 112.2.1. How do you preserve milk? [_____]

113. Does the farmer own a milking machine?
113.1. Yes □
113.2. No □

114. Do you process milk?
114.1. Yes □
114.2. No □

115. If yes, do you sell cheese?
115.1. Yes □
115.2. No □

116. List the dairy products that you process
[_____]

G. Economic info

117. What is the overall house income? [_____]
118. Is there a source of income for the house, other than the farm?
118.1. Yes □ 118.1.1. Explain: [_____]
118.2. No □
119. What is the yearly income of the farm?
[_____]

120. What are the overall farm expenses?
[_____]
120.1. Feeding cost [_____]
120.2. Fuel/electricity/power: [_____]
120.3. Labor: [_____]
120.4. Vaccines and animal health: [_____]
120.5. Rent of pastures: [_____]
120.6. Rent of farm: [_____]
120.7. Water: [_____]
120.8. Manure sale: [_____]

121. Do you rely on direct help?
121.1. Yes □ If yes, specify: 121.1.1. Ministry of Agriculture
121.1.2. COOP/NGO
121.2. No □

H. Farmers' perception to change

Did you notice changes in climate during the last 10 years?		No		Yes	Explain
Did you notice changes productivity during the last 10 years?		No		Yes	Explain
Did you notice changes in the pastures during the last 10 years?		No		Yes	Explain
Did you change the herd movement?		No		Yes	Explain
Did you notice changes in the market and prices?		No		Yes	Explain
In your opinion, what are the reasons behind these changes?					
How did these changes affect the farm activities?					
How did these changes affect animal behavior/health?					

ABSTRACT

Durabilité des systèmes agropastoraux soumis aux changements globaux reflétée par l'analyse de la perception des pasteurs et de la filière: une étude de cas libanaise

Mots-clés : durabilité, agro-pastoralisme, parcours, perception des pasteurs, filière, Liban.

Le changement global est un processus complexe englobant des changements environnementaux, climatiques, sociaux, économiques, culturels et politiques. Il a toujours affecté les systèmes agropastoraux du monde entier et compromis leur durabilité, entraînant de profonds changements tels qu'un déclin de la ressource pastorale, du nombre de troupeaux, une tendance au sédentarisme, une diversification des moyens de subsistance et même un abandon d'activités pastorales. Partant de l'hypothèse que les agro-pasteurs de régions différentes font face à des défis similaires et partagent les mêmes contraintes mais que leurs stratégies d'adaptation sont affectées par leur contexte local qui améliore ou affaiblit leur durabilité, ce projet de recherche vise à évaluer la durabilité des systèmes agro-pastoraux au Liban face au changement global. Premièrement, les défis affectant la durabilité des systèmes agro-pastoraux au Liban ont été identifiés à travers une revue de la littérature sur les pâturages et l'usage des terres. Six principaux défis ont été identifiés : i) Manque de politique spécifique au pastoralisme et au régime foncier, ii) Urbanisation et migration rurale, iii) Concurrence de l'agriculture, iv) Déforestation et surpâturage, v) Manque de compétences techniques et de données pour la gestion des parcours et vi) Variabilité climatique. Deuxièmement, la perception du changement des éleveurs de petits ruminants de la Beqaa Ouest a été évaluée et leurs stratégies d'adaptation identifiées. Les contraintes perçues par les pasteurs variaient selon le système de production auquel ils appartenaient et étaient principalement liés à l'accès et la qualité des pâturages, aux incertitudes de marché et politiques, à la variabilité climatique, aux conditions socio-économiques sur l'exploitation et à la santé animale. En l'absence de soutien gouvernemental, les agriculteurs de tous les systèmes ont mis au point des stratégies d'adaptation à court terme qui impliquent plus de temps consacré aux pâturages, davantage de fourrage et une réduction de la taille du troupeau. De plus, le mouvement des troupeaux se limitait aux pâturages autour des villages ce qui témoignait du passage au sédentarisme. Troisièmement, la durabilité des systèmes agro-pastoraux de la Beqaa Ouest et du Chouf a été évaluée à travers l'analyse de la filière du fromage traditionnel «kishk» typiquement préparé avec du lait de chèvre. La production de kishk a été maintenue par les femmes rurales et le kishk s'est révélé être un produit résilient malgré les changements dans les variétés de blé et les fluctuations dans la source et la quantité de lait. Les systèmes de petits ruminants se sont avérés plus résilients que les systèmes de production de blé. Quatrièmement, l'analyse de systèmes de bovins laitiers dans la zone d'étude a pour but de scénariser l'intensification possible pour quelques agro-pasteurs, notamment l'optimisation de l'alimentation, l'utilisation de technologies appropriées, la diversification et accès au marché. Enfin, une analyse comparative a été réalisée entre l'étude de cas libanaise et sept courts métrages filmés dans des zones de parcours contrastées (plateau tibétain, grande prairie canadienne, région bédouine égyptienne, Sahel sénégalais, pampa uruguayenne, Serra Gaucha brésilienne et Provence française). Les propos et contraintes signalées dans les sept films ont été confrontés à ceux du Liban en particulier la variabilité du climat et la nécessité de politiques spécifiques régulant l'utilisation des parcours et valorisant leur diversité. Les agro-pasteurs du monde entier sont confrontés à des forces similaires de changement comme la variabilité climatique, l'inadéquation des politiques et l'avenir incertain de la jeunesse. La mise en œuvre de politiques pastorales spécifiques intégrant la perception des agro-pasteurs assure l'efficacité de ces politiques et la durabilité de ces systèmes.

Sustainability of agro-pastoralist systems undergoing global changes as reflected by farmers' perception and value chain analysis: a Lebanese case-study

Keywords: sustainability, agro-pastoralism, rangeland, farmers' perception, value chain, Lebanon

Global change is a complex process encompassing environmental, climatic, social, economic, cultural and political changes. It has always affected agro-pastoral systems worldwide and compromised their sustainability resulting in tremendous changes of the pastoral systems including a decline in rangeland resources and the number of herds, sedentarism trends, diversification of livelihoods and even abandon of farming activities. Based on the hypothesis that agro-pastoralists in contrasted areas of the world face similar challenges and share same concerns but their adaptive strategies are affected by their local context which either enhances or weakens their sustainability, this research project aims at assessing the sustainability of agro-pastoral systems in Lebanon which are undergoing global forces of changes. First, the challenges affecting the sustainability of agro-pastoral systems in Lebanon have been identified through a review of the literature on pasture and land use in Lebanon. Six main challenges have been identified: i) Lack of policies and laws related to pastoralism and land tenure; ii) Urbanization and rural migration; iii) Encroachment by agriculture; iv) Deforestation and overgrazing; v) Lack of technical skills and data for range management; and vi) Climate variability. Second, the perception of change of small ruminant farmers in the West Bekaa of Lebanon has been assessed and their adaptation strategies identified. The constraints perceived by the farmers varied based on the production system they belonged to and were mainly related to pasture access and quality, market and political uncertainties, climate variability, on-farm socio-economic conditions and animal health. In the absence of government support, farmers from all systems developed short-term adaptive strategies involving more time spent on pastures, more feed supplementation and a decrease in herd size. Moreover, herd movement was limited to the pastures around the villages hence evincing the shift to sedentarism. Thirdly, the sustainability of agro-pastoral systems in the West Bekaa and Chouf was evaluated through the analysis of the value chain of the traditional cheese "kishk" typically prepared with goat milk. Kishk production has been maintained by rural women and kishk proved to be a resilient product despite the changes in wheat varieties and fluctuations in the source and quantity of milk. Small ruminant systems were found to be more resilient than wheat production systems. Fourthly, the dairy bovine systems in the West Bekaa and Chouf-Aley were identified using a system typology, in an attempt to present them as a model for intensification for some agro-pastoralists particularly in feed optimization, use of appropriate technologies, diversification of activities and market access. The dairy bovine system provided an insight for the intensification of the small ruminant sector in Lebanon for those who can afford it. At last, a comparative analysis was done between the Lebanese case-study and seven short movies filmed in contrasted areas of rangelands (Tibetan Plateau, Canadian Great Prairie, Egyptian Bedouin area, Senegalese Sahel, Uruguayan Pampa, Brazilian Serra Gaucha and French Provence). The gaps and challenges reported in the seven movies were found comparable to those identified in Lebanon specifically in regard to climate variability and the need for specific policies that regulate the use of rangelands and valorize their diversity. Agro-pastoralists in Lebanon and around the world are facing similar forces of change namely climate variability, inadequacy of rangeland policies and the uncertain future of youth. The implementation of specific rangeland policies integrating the perception of agro-pastoralists ensures the efficiency of these policies and the sustainability of traditional pastoral systems.