



Characterization of the aquafeed sub-sector in the Kyrgyz Republic

An aquafeed value chain analysis and preparation of a business plan for establishing a feed mill



Cover photographs:

Top left: Feed and feed ingredient retail shop, Bishkek, the Kyrgyz Republic. *Top right:* Imported extruded floating feed for trout (left) and locally produced compressed sinking pellets for carps (right) (courtesy of FAO/Thomas A. Shipton).

Bottom left: Cage culture of the Siberian sturgeon (*Acipenser baerii*), Bishkek, the Kyrgyz Republic. *Bottom right:* Frozen imported and fresh local fish being sold in a supermarket in Bishkek, the Kyrgyz republic.

Cover design:

Mohammad R. Hasan and José Luis Castilla Civit.

Characterization of the aquafeed sub-sector in the Kyrgyz Republic

An aquafeed value chain analysis and preparation of a business
plan for establishing a feed mill

by

Abu H.M.S. Islam

FAO Consultant

Mymensingh, Bangladesh

and

Mohammad R. Hasan

Former Aquaculture Officer

Aquaculture Branch

FAO Fisheries and Aquaculture Department

Rome, Italy

Required citation:

Islam, A.H.M.S. and M.R. Hasan. 2018. *Characterization of the aquafeed sub-sector in the Kyrgyz Republic: an aquafeed value chain analysis and preparation of a business plan for establishing a feed mill.* FAO Fisheries and Aquaculture Technical Paper no. 620. Rome, FAO. 60 pp. Licence: CC BY-NC-SA 3.0 IGO.

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

ISBN 978-92-5-130984-1

© FAO, 2018



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode>).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons license. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition.

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization <http://www.wipo.int/amc/en/mediation/rules> and any arbitration will be in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website (www.fao.org/publications) and can be purchased through publications-sales@fao.org. Requests for commercial use should be submitted via: www.fao.org/contact-us/licence-request. Queries regarding rights and licensing should be submitted to: copyright@fao.org.

Preparation of this document

Preparation of this technical paper was coordinated by Dr Mohammad R. Hasan of the Aquaculture Branch, FAO Fisheries and Aquaculture Department. This paper presents the results of the FAO Technical Cooperation Programme (TCP) Project “Enhancing aquaculture production for food security and rural development through improved feed value chain, production and use (TCP/KYR/3502)”, which was implemented between May 2014 and April 2017 in the Kyrgyz Republic. During implementation of this project, FAO collaborated with the Department of Pastures, Livestock and Fisheries (DPLF) of the Ministry of Agriculture, Water Resources and Processing Industry (MAWRPI) of the Government of the Kyrgyz Republic. This publication will contribute to organizational outcome 10101: Improving capacities of governments and stakeholders for developing sectoral and cross-sectoral policy frameworks and investment plans and programmes for food security and nutrition.

Dr Junning Cai, Aquaculture Officer, Aquaculture Branch, FAO Fisheries and Aquaculture Department, Rome, Italy and Dr Thomas A. Shipton, International Consultant, FAO TCP Project (TCP/KYR/3502) are acknowledged for their assistance during the implementation of the study and for reviewing the manuscript prior to its publication.

The authors would like to express their sincere thanks to the numerous feed mill owners, trout and carp farmers and all other stakeholders involved in the broader aquaculture value chain who were interviewed, consulted or otherwise took part in the study, for their contribution to the qualitative and quantitative data and information. The Office of the FAO Representation in the Kyrgyz Republic is deeply appreciated for their timely assistance in implementing the project.

Dr Sarah L. Poynton edited this technical paper for its linguistic quality and technical content. Most of the photographs in this technical paper were provided by the first author Dr Abu H.M.S. Islam. Where this is not the case, due acknowledgements are made to the contributors. For consistency and conformity, the use of scientific and English common names of fish species in this technical paper was used according to FishBase (www.fishbase.org/search.php).

Ms Marianne Guyonnet and Ms Lisa Falcone are acknowledged for their assistance in quality control and adoption of FAO house style. Mr José Luis Castilla Civit prepared the layout design for printing. The publishing and distribution of the document were undertaken by FAO, Rome. Dr Dorjee Kinlay, FAO Representative in the Kyrgyz Republic is acknowledged for providing the support and advice necessary to complete this publication.

Abstract

Among many factors, feed is a limiting factor, which accounts for a major share of the total operational cost of the aquaculture sector in the Kyrgyz Republic. This study analyzes the value chain of the aquafeed sub-sector, including identification of possible constraints, and development of a business plan for establishing a small-scale aquafeed mill in the Kyrgyz Republic. This is the first post-USSR country case study which assesses the current status of the aquafeed sub-sector, aquafeed value chain, on-farm feeding and feed management practices, performance of different actors in terms of value addition and profitability, and feed regulations, institutions and policies, and presents a business plan for small-scale aquafeed in the Kyrgyz Republic. The study identifies the strengths, weaknesses, opportunities and threats in this sub-sector, and suggests development strategies to improve the performance of the feed industry and farmers' access to better feeds and ultimately support development of the aquaculture sector in the Kyrgyz Republic. Analysis of the quantitative data shows that the Kyrgyz aquafeed sub-sector is still in its infancy and its value chain is very simple, comprising only a few actors: feed input suppliers, aquafeed producers, aquafeed traders and fish farmers; all of them doing their business profitably.

Feed is a crucial input in fish farming, accounting for 65 – 75 percent of the operational cost of fish production, thus a substantial part of the fish farmers' income is transferred to the feed manufacturers. Good quality feed is a prerequisite for increasing aquaculture productivity in the Kyrgyz Republic, where currently fish farmers primarily use locally produced farm-made feed with only a small amount of imported commercial feed. With the potential challenges of aquaculture intensification and lack of quality feed, there is clear justification for establishment of a commercial feed mill in the Kyrgyz Republic, to produce feeds for carps and trout. The primary competition for a new feed mill would be the existing locally manufactured feeds, and the imported commercial feed. The imported feeds are mainly for trout, are often expensive and are not available in all local markets in the Kyrgyz Republic. It is expected that a public-private partnership operated feed mill in the Kyrgyz Republic, with a capacity of 500 kg/hour, will be profitable; with an anticipated profit of USD13 617 in year one, rising to USD 97 980 in year five. The Internal Rate of Return (IRR) of such a mill is estimated to be 19.1 percent, which is reasonably good. Therefore, the study recommends establishing a public-private partnership aquafeed mill in the Kyrgyz Republic that would be feasible, viable and profitable.

The major factors impacting performance of the aquafeed value-chain relate to the feed ingredients, feed production, fish farmers, marketing and other service providers (such as financial, academic and research institutions, and extension services). The aquafeed value chain shows reasonable promise, although there are constraints and no institutional, regulatory and policy environment to oversee development of this sub-sector. The aquafeed sub-sector can play an important role in aquaculture sector development, as it has strong backward and forward linkages with the aquaculture sector, which can play an important role in the overall development of the Kyrgyz economy. The study recommends measures to develop the aquafeed sub-sector including establishment of additional feed mills, use of locally available raw feed materials, developing and strengthening quality control and inspection facilities, providing training and better organizational management of fish farms and improving the institutional, legal and policy environment.

Contents

Preparation of this document	iii
Abstract	iv
Abbreviations and acronyms	vii
Executive summary	viii
General introduction	x
SECTION A:	
Characterization of the aquafeed sub-sector in the Kyrgyz Republic: an aquafeed value chain analysis	1
1. Background	1
2. Introduction	1
3. Overview of aquaculture and the aquafeed sub-sector in the Kyrgyz Republic	3
3.1 Development of aquaculture	3
3.2 Potential for growth of aquaculture	4
3.3 Fish consumption and increasing demand	5
3.4 Lack of quality feed as a constraint to production	6
4. Methodology of the study	8
4.1 Data collection and study area	8
4.2 Value chain analysis (VCA)	9
4.3 Profitability analysis	10
4.4 SWOT analysis	10
5. Results and discussion	11
5.1 Value chain mapping and marketing channels	11
5.2 Value chain actors, value addition functions, and governance in the aquafeed value chain	12
5.3 Regulatory, institutional and policy frameworks for aquafeed value chain development in the Kyrgyz Republic	14
5.4 Cost and return analysis of value chain actors	17
5.4.1 Profitability analysis of feed millers	17
5.4.2 Profitability analysis of feed and feed ingredient wholesalers and retailers	17
5.4.3 Profitability analysis of rainbow trout and carp farmers	18
5.5 SWOT analysis of aquafeed value chain development in Kyrgyz Republic	21
5.6 Factors affecting aquafeed value chain efficiency	22
6. Conclusion and recommendations	24

SECTION B:	
Business plan and feasibility analysis of establishing a feed mill under a public–private partnership (PPP) lease agreement in the Kyrgyz Republic	29
1. Background and history	29
2. Goals and objectives of the study	29
3. Description of products and services	30
4. Public-private partnership feed mill profile	30
5. Market assessment	30
6. Competition assessment	34
7. Marketing strategies	34
8. Financial analysis	36
8.1 Start-up investments	36
8.2 Profitability analysis for the feed mill	37
8.3 Cash flow analysis	37
9. Sensitivity analysis	39
9.1 Impact of changes in market demand for feed	40
9.2 Impact of change in price of feed	40
9.3 Impact of change in price of feed ingredients	40
10. Sustainability issues	40
10.1 Ownership protection aspects	40
10.2 Government support	40
10.3 Credit availability, including working capital	40
10.4 Investment protection mechanisms	44
10.5 Capacity building and extension support	44
10.6 Food safety and quality issues	44
11. Conclusions	44
References	46

Abbreviations and acronyms

BCR	benefit cost ratio
CBD	Convention on Biological Diversity
CIS	Commonwealth of Independent States
CU	Customs union
DC	depreciation cost
DDGS	distiller's dried grains with solubles
DPLF	Department of Pastures, Livestock and Fisheries of MoAFIM
EAEU	Eurasian Economic Union
EC	European Commission
FAO	Food and Agriculture Organization of the United Nations
FC	fixed cost
FCR	feed conversion ratio
FGD	focus group discussion
FIN	Finland
GAIN	Global Alliance for Improved Nutrition
GCP	Government Cooperative Programme
GDP	gross domestic product
GM	gross margin
GR	gross return
ha	hectare
HACCP	hazard analysis and critical control points
IBIL	Independent Bread Inspection Laboratory
IRR	internal rate of return
ISO	International Organization for Standardization
KGS	Kyrgyzstani Som
KIS	key informant survey
KII	key informant interview
KYR	Kyrgyzstan/Kyrgyz Republic
LUC	land use cost
MAWRPI	Ministry of Agriculture, Water Resources and Processing Industry
MoAFIM	Ministry of Agriculture, Food Industry and Melioration
MP	muriate of potash
NGOs	non-government organizations
NPV	net present value
NR	net return
NSC	National Statistical Committee of the Kyrgyz Republic
PPP	public-private partnership
SAEF	State Agency on Environment and Forestry
SWOT	strengths, weaknesses, opportunities, and threats
TC	total cost
TCP	Technical Cooperation Programme
TFC	total fixed cost
TR	total return from output
TSP	triple superphosphate
UNDP	United Nation Development Program
UNIDO	United Nations Industrial Development Organization
USD	United States dollar
USSR	Union of Soviet Socialist Republics
VAT	value added tax
VC	variable cost
VCA	value chain analysis

Executive summary

This technical paper presents the findings of the FAO Technical Cooperation Programme (TCP) Project (TCP/KYR/3502) “Enhancing aquaculture production for food security and rural development through improved feed value chain, production and use,” which was implemented between May 2014 and April 2017 in the Kyrgyz Republic. The report comprises: (i) aquafeed value chain analysis and identification of related constraints, (ii) development of a business plan (including a feasibility study) for a small-scale aquafeed manufacturing plant, (iii) review and revision of policy and regulatory frameworks for aquafeed manufacturing, (iv) development of institutional, policy and regulatory frameworks for aquafeed production, quality control and management, and (v) review of the current legislative, policy and management dispensations for aquaculture, including aquafeed manufacturing, in the Kyrgyz Republic. The report is based on two sources: a) review of existing institutional, policy, and legislative documents, and b) surveys, observations, focus group discussion and interviews with key aquafeed value chain actors. The first part of the paper (Section A) presents the findings of the aquafeed value chain analysis, and the second part (Section B) presents a business plan for establishing a small aquafeed manufacturing plant in the Kyrgyz Republic.

Feed is a limiting factor in the emerging aquaculture sector in the Kyrgyz Republic, and accounts for a major share of the total operational costs. Exploration of the opportunities for development and reform of the aquafeed sub-sector in the Kyrgyz Republic must include sound knowledge of the activities performed by different actors in the aquafeed value chain, and their possible constraints. The present study identifies the strengths, weaknesses, opportunities and threats in the sub-sector, and suggests development strategies to improve the performance of the feed industry, give farmers’ access to better feed, and ultimately support the development of the aquaculture sector in the Kyrgyz Republic. Quantitative data were collected, for each link in the value chain, through structured and semi-structured questionnaires that were collected from key stakeholders, including feed manufacturers, feed and feed ingredient traders, and fish farmers from different regions of the country.

The results show that the aquafeed sub-sector of the Kyrgyz Republic is still in its infancy, and its value chain is very simple, comprising feed input suppliers, aquafeed producers, aquafeed traders and fish farmers. Most of the trout farmers (80–85 percent) use commercially manufactured pellet feeds, mostly imported from selected countries of Europe and from the Russian Federation: the minority of the farmers (15–20 percent) use farm-made feeds, prepared by mixing locally produced and imported ground feed ingredients. In contrast, most of the carp farmers (90–95 percent) use farm-made feed produced from locally available feed ingredients, while the remaining farmers (5 – 10 percent) use imported commercial feeds. Most of the feed ingredients used to produce aquafeed in the Kyrgyz Republic are locally available and domestically produced, except fishmeal, vitamins and premixes which are imported from Russia and Kazakhstan.

The few feed mills in the Kyrgyz Republic that do produce aquafeed produce compressed sinking pellets, mostly for use in their own farm, with the remainder being sold to neighboring farms. These compressed pellets are sold directly to the farmers, (with payment in cash or on credit), or are sold through intermediaries such as wholesalers and retailers. Feed ingredient costs represents 85–95 percent of the total operating costs of the feed mill, and feed costs represents 65–75 percent of the total operating cost of aquaculture. The major factors impacting the performance of the value

chain relates to the feed ingredients, feed production, fish farmers, marketing and other service providers such as financial, academic and research institutions, and extension services. Although young, the aquafeed value chain in the Kyrgyz Republic shows immense promise, however there are constraints, and an institutional, regulatory and policy environment to oversee the development of this sub-sector is currently lacking.

The aquafeed sub-sector can play an important role in crop production and aquaculture sectors, as it uses inputs from crop production sector (for example maize, wheat and barley) in its production process, reflecting backward linkage. This sub-sector also supplies feed as the major inputs to the aquaculture sector, indicating the forward linkage. Thus, the aquafeed value chain can play an important role in the overall development of the Kyrgyz economy. The study recommends measures to develop the sub-sector, including the establishment of feed mills using locally available raw materials, developing and strengthening quality control and inspection facilities, providing training and better organizational management of fish farms, and improving the institutional, legal and policy environment.

Good quality feed is a prerequisite for increasing aquaculture productivity in the Kyrgyz Republic, where carp farmers in particular use only a minimal amount of imported commercial feed when locally produced farm-made feed is available; in contrast trout farmers mostly use commercial feed, which is imported.

There is a need for intensification of aquaculture in the Kyrgyz Republic, to be supported by using increased amounts of commercial feed. The potential challenges for aquaculture intensification and lack of quality feed, strongly justifies the establishment, in the Kyrgyz Republic, of a commercial feed mill producing feed for carps and for trout. The Kyrgyz Republic produces large amount of grain and oilseed (such as maize, oat, wheat, barley and sunflower), and a new feed mill in the Kyrgyz Republic can supply feed throughout the country, as there is good transport infrastructure. The primary competitors would be locally manufactured farm-made feeds and imported commercial feeds. Locally manufactured feeds are often poor quality and are mainly used for carps. In such farm-made feed, there is very little standardization of quality in terms of major nutrients (e.g., such as protein, lipid) and pelletability. Meanwhile, imported feeds, mainly for trout, are often expensive and may not be available in all local markets. A feed mill in the Kyrgyz Republic, operated by a public-private partnership, with a capacity of 500 kg/hour, is expected to be profitable, with an anticipated profit of USD13 617 in year one, increasing to USD97 980 in year five. The internal rate of return (IRR) of such a feed mill is estimated to be robust, at 19.10 percent. Therefore, the study recommends establishing a public-private partnership aquafeed mill in the country that would be feasible, viable and profitable.

General introduction

Aquaculture in Central Asia remains a largely underdeveloped sector, despite the significant investments made during the era of the Union of Soviet Socialist Republics (USSR). The subsequent fall of the USSR (1989–1991), and the development of the Commonwealth of Independent States (CIS), resulted in a precipitous drop in production. Since achieving independence from the USSR in the early 1990s, the central Asian region experienced a marked decline in aquaculture production. By 2004, production from the five former USSR republics in central Asia (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan) accounted for just 3 343 tonnes (FAO, 2018), which was only 7.50 percent of the aquaculture production in 1991 (44 609 tonnes). However, since 2005, aquaculture production in these five central Asian countries has increased from 3 995 (2005) tonnes to 42 343 tonnes in 2016. In the Kyrgyz Republic, which is the focus of this report, the pattern was similar: aquaculture production declined markedly from 1 135 tonnes in 1989 to only 12 tonnes in 2003, and then started recovering from 20 tonnes in 2004 to 1 931 tonnes in 2016 (FAO, 2018).

The reasons for the post-independence decline in aquaculture production are complex, and include political, institutional, economic, technical and social factors. Notably, the transition from a state lead economy to a market economy resulted in a significant decrease in government financing and investment into the sector. Funding for research and development was no longer forthcoming, and state subsidies to maintain existing infrastructure decreased significantly. Furthermore, after the transition to democracy, approximately 90 percent of the state owned farms in the Kyrgyz Republic were privatized. However, concurrent with privatization, there was a general decline of state institutions and governance structures, which - when combined with poor legislative frameworks to support investment - deterred private sector involvement in the aquaculture sector. As a result, many of the once-functioning fish farms now lie abandoned.

Development of this sector in the Kyrgyz Republic is further constrained by the scarcity of technical specialists, and by the limited number of trained aquaculture personnel in both the public and private sectors. In addition, all levels of the value chain have been negatively impacted by the decline or closure of support industries (such as feed production, fish hatcheries and seed suppliers), and by limited access to cost-effective imported alternatives. Thus, management of the supply chain is problematic.

Despite a slight increase in recent years, fish consumption in the Kyrgyz Republic is very low, with a *per capita per annum* fish consumption of only 2.3 kg in 2013. The low *per capita fish* consumption is attributable to the absence of a fish eating culture, and to the high price of fish (compared to other more popular foods such as beef, mutton, and chicken). The elasticity of fish consumption is directly related to its market price. The higher the price, the less the consumption. In 2015, the country imported 7 062 tonnes of fish valued at USD 10 million (FAO, 2018), produced only 1 068 tonnes of fish by aquaculture (FAO, 2018). However, demand for fish products in the Kyrgyz Republic is expected to increase, due to the anticipated population growth and a rise in tourism in the country, particularly in the Issyk-Kul region in the east of the country. It is anticipated that increases in population and tourism may significantly increase the demand for fish products in the coming years. Thus, there is clear scope for further growth of the aquaculture sector.

To realize this potential, the scope of aquaculture farm production efficiencies must be improved, including by: (i) promoting the manufacture and use of high quality, cost-

effective and safe feeds, (ii) improving the feed supply chain, and (iii) optimizing on-farm feed management practices. These interventions are expected to enhance the economic performance of the farming operations, and stimulate sectoral growth. Typically, feed costs account for 65–75 percent of operational costs in aquaculture, and farmers need access to high quality feeds at reasonable prices to ensure profitability.

However, in the Kyrgyz Republic, the supply of good quality and nutritionally complete feeds remains problematic. There is no commercial manufacturer of trout and carp feed in operation in the country, and consequently most farmers do ad hoc feeding with available feed ingredients, or have to rely on imported feeds (primarily from Finland via the Russian Federation). The relatively high costs associated with imported feeds presents affordability issues for the resource-poor farmers, and use of expensive imported feed is only economically justifiable in the relatively high-value trout culture.

Poor quality feeds and feed management practices typically manifest as low growth rates, low farm production, and poor economic returns. Low revenues result in the farmers' inability to afford good quality feed inputs, thus perpetuating the cycle of inefficiency and poor performance.

Provision of high quality feeds that satisfy the nutritional requirements of the cultured species (primarily rainbow trout, carps and sturgeons), and optimize growth, is a prerequisite for improving production yields, lowering production costs, improving economic returns, and lowering risk.

Breaking this cycle of inefficiency requires a holistic approach to improving feed quality, the supply chain, and feed management on the farms. Currently, a number of issues constrain feed manufacturing and management in the Kyrgyz Republic. The old manufacturing technologies used by the farmers and small-scale feed manufacturers are restricted to the production of simple, low quality, compressed (sinking) pellets. Crucially, there is no in-country manufacturing technology available to produce the cost-effective extruded (floating) feeds, which would improve nutrient digestibility, simplify on-farm feed management, and improve production efficiencies.

Moreover, there is no institutional capacity to regulate the feed manufacturing processes, and quality control and management: neither is there a dedicated feed analytical laboratory to test feed ingredients, feed additives and manufactured feed quality and safety. The legal dispensation, notably the 1997 law on the “Fish Industry” and its amendments, does not address feed manufacturing issues per se, and there are no policies, guidelines or protocols in place to manage feed standards. The lack of regulatory control and monitoring raises significant concerns about feed safety, and leaves the market open to unscrupulous feed ingredient suppliers and manufacturers who may sell low quality or adulterated products to farmers who have no legal recourse, or technical support to establish the quality of the products they purchase.

Against this backdrop, FAO sought to revitalize and develop and revitalize the aquaculture sector in the Kyrgyz Republic, via a Technical Cooperation Programme (TCP) Project (TCP/KYR/3201) “Enhancing aquaculture production for food security and rural development through improved feed value chain, production and use”.

The TCP Project, of which the present report is a part, has four specific aims:

1. Review of the country's aquafeed industry.
2. Analyze the aquafeed value chain, and identify constraints to the aquafeed supply chain, including review of current aquafeed manufacturing processes used by farm-made and small- to medium-scale aquafeed manufacturers.
3. Develop a business plan (including a feasibility study) for private sector investment into small- and medium-scale aquafeed manufacturing.
4. Review and revise the current legislative, regulatory, policy, institutional and management frameworks to promote the production of aquaculture and aquafeeds including the institutional mandates, roles and responsibilities.

The first part of the report, Section A, presents the aquafeed value chain analysis, and identifies constraints to the aquafeed supply chain in the Kyrgyz Republic, including the institutional, policy and regulatory framework. Section A is based on primary and secondary data collected from different segments of the value chain, and on review of related secondary literature.

The second part of the report, Section B, presents a business plan for establishing a small-scale aquafeed production facility in the Kyrgyz Republic.

SECTION A:

Characterization of the aquafeed sub-sector in the Kyrgyz Republic: an aquafeed value chain analysis

1. BACKGROUND

This report presents the key outcomes of the FAO Technical Cooperation Programme (TCP) Project (TCP/KYR/3502) “Enhancing aquaculture production for food security and rural development through improved feed value chain, production and use”. The project implemented between May 2014 and April 2017 is focused on aquafeed value chain analysis, and the identification of constraints to the aquafeed supply chain, in the Kyrgyz Republic. The overall objective was to assess the aquafeed value chain in the Kyrgyz Republic, by using primary and secondary data collected from different value chain actors. Improvements are needed in farm production efficiencies, which can be achieved by promoting the manufacture and use of high quality, cost-effective and safe feeds using locally available feed ingredients, strengthening the feed supply chain, and optimizing on-farm feed management practices. This study covered both the upstream and downstream stakeholders in the value chain, and identified constraints to the sustainable development of the aquafeed supply chain in the Kyrgyz Republic.

2. INTRODUCTION

The Kyrgyz Republic is a landlocked mountainous country, with a population of around 5.9 million. Two thirds of the population live in rural areas, and 32.1 percent of the population lives below the national poverty line (ADB, 2017). Agriculture, primarily livestock raising, is a significant part of the economy. Fish production, in contrast, currently contributes less than 0.1 percent to the gross domestic production (GDP). Production is dominated by aquaculture and culture-based fisheries, as there are limited natural resources for capture fisheries, due to the cold temperature and the oligotrophic (nutrient-poor) nature of the rivers and most of the lakes. However, the aquaculture sector can play an important role in rural development in the Kyrgyz Republic, as there are abundant water resources, including surface water, lakes, reservoirs, irrigation networks, rivers, ponds, springs, wells and artesian basins, which represent large production potential. This potential can be unlocked with good management, introduction of modern technologies, and the appropriate rules, regulations, policy and incentives to encourage private sector investments.

Historically, the aquaculture sector in the Kyrgyz Republic has been based on polyculture of carps in ponds and cage culture of trout. Apart from the above two species groups (carps and trout), sturgeon are a recent addition to the cultured species in the Kyrgyz Republic.

The main cultured species comprise the silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), crucian carp (*Carassius carassius*), grass carp (*Ctenopharyngodon idella*), rainbow trout (*Oncorhynchus mykiss*) and sturgeons (Siberian sturgeon, *Acipenser baerii* and Russian sturgeon, *Acipenser gueldenstaedtii*) (FAO, 2014; Kustareva and Naseka, 2015; Thomas A. Shipton, personal communication, 2018).

Although the Government of the Kyrgyz Republic recognizes the importance of the aquaculture and fisheries sector, since independence from the USSR in 1990,

fish production had declined sharply until 2006¹. In 2006, the fish production in the Kyrgyz Republic was estimated at only 57 tonnes, with the 1989 production of 1 447 tonnes (Table 1) (FAO, 2018). This drastic fall in fish production has had a negative impact on poverty alleviation, and on fish consumption, food and nutritional security (Ilibezova *et al.*, 2013). The main factors responsible for the decline in aquaculture production were the absence of good quality seed and feed, and of appropriate policy, legal and institutional frameworks (FAO, 2014). Since 2007, fish production has slowly increased, however production remains inefficient, and is based on extensive and low input culture systems.

TABLE 1

Annual aquaculture and capture fisheries production (tonnes) in the Kyrgyz Republic, 1988 and 2016

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Aquaculture	1 108	1 135	982	974	642	223	163	207	185	168	162	71	58	144	94
Capture fisheries	212	312	327	225	201	127	131	185	145	85	85	48	52	180	151
Total production	1 320	1 447	1 309	1 199	843	350	294	392	330	253	247	119	110	324	245
Contribution (%) of aquaculture to total production	83.9	78.4	75.0	81.2	76.2	63.7	55.4	52.8	56.1	66.4	65.6	59.7	52.7	44.4	38.4
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Aquaculture	12	20	20	20	107	92	133	352	395	297	300	578	1 068	1 931	
Capture fisheries	63	7	26	37	14	8	10	27	60	90	120	227	31	89	
Total production	75	27	46	57	121	100	143	379	455	387	420	805	1 099	2 020	
Contribution (%) of aquaculture to total production	16.0	74.1	43.5	35.1	88.4	92.0	93.0	92.9	86.8	76.7	71.4	71.8	97.2	95.6	

Notes: All data are from freshwater; the Kyrgyz Republic is a landlocked country, and thus has neither has marine culture or marine capture fisheries.

Source: FAO (2018).

To break the inefficiency of the fish production cycle in the Kyrgyz Republic, a holistic approach is needed for improvements of feed quality, feed manufacturing process, and on-farm feed management. Unlocking the value chain, improving supply chain management, and optimizing regulatory and governance (including appropriate policy and legal and institutional frameworks) also deserve necessary consideration (Ilibezova *et al.*, 2013). Aquafeed research in other countries shows that adoption of nutritionally complete commercial aquafeed increased both fish production and farmer's income (Ahmed, 2007), and the same positive outcomes can be expected for the Kyrgyz Republic. However, despite the importance of strengthening the aquafeed sub-sector for enhancing aquaculture in the Kyrgyz Republic, the status and performance of this sector are not well documented or understood.

Against this backdrop, the present study aims to characterize the value chain of the aquafeed sub-sector in the Kyrgyz Republic, particularly by identifying the issues and constraints for improving efficiency. Specifically this section of the study aims to: (1) map the aquafeed value chain to identify the main actors, and the flow of product and information through the chain; (2) understand the financial performance, in terms of profitability of the different actors in the chain; (3) document the status and gaps of regulation, institutions and policies, for a vibrant aquafeed sub-sector; and (4) identify (via SWOT analysis) the major strengths, weaknesses, opportunities and threats impacting the different actors in the chain, and provide suggestions for strategies to enhance the strengths and opportunities, and address the weaknesses and threats.

¹ To support this sector, the Kyrgyz government, along with national and international organizations, developed and adopted "The Strategy for Fisheries and Aquaculture Sector Development and Management in the Kyrgyz Republic (2008–12)".

To meet these study objectives, the assessment methodology was a value chain analysis, in which the primary information was collected through a field survey, using structured and semi-structured questionnaires for the different actors in the aquafeed chain in the Kyrgyz Republic. Value chain analysis (VCA) is a “multi-dimensional assessment of the performance of value chains, including the analysis of product flows, information flows and the management and control of the value chain” (Taylor, 2005). The VCA framework is a useful tool for assessing performance, and it is increasingly used to analyze performance of the fisheries and aquaculture sectors (Velu *et al.*, 2009; Christensen, Steenbeek and Failler, 2011; Macfadyen *et al.*, 2012; Mamun-Ur-Rashid *et al.*, 2013; Thyresson *et al.*, 2013; Nasr-Allah *et al.*, 2014; El-Sayed, Dickson and El-Naggar, 2015; Islam, 2016).

The organization of the main elements of Section A of this report (aquafeed VCA) is as follows: Section 3, overview of aquaculture and the aquafeed sub-sector in the Kyrgyz Republic; Section 4, methodology of the study; Section 5, results and discussion; and Section 6, conclusion and recommendations.

3. OVERVIEW OF AQUACULTURE AND THE AQUAFEED SUB-SECTOR IN THE KYRGYZ REPUBLIC

3.1 Development of aquaculture

Within the fisheries sector in the Kyrgyz Republic, aquaculture and culture-based fisheries have dominated, and continue to dominate, total fishery production (Figure 1). In 1988, 83.9 percent of total fisheries production was originated from aquaculture and since then the contribution of aquaculture varied considerably ranging from 16 – 97 percent. Generally the aquaculture production decreased from 1988 to 2003, and then increased, now the aquaculture contributing to total fish production is the highest ever (97.1 percent in 2015 and 95.6 percent in 2016) (Table 1).

Aquaculture in the Kyrgyz Republic dates back to the 1930s. Initial developments focused on the introduction of farmer cooperatives, and the introduction of exotic species [e.g. Amu-Darya trout (*Salmo trutta oxianus*)², common marinka/sattar snowtrout (*Schizothorax curvifrons*), *Squalidus intermedius*, sevan trout (*Salmo ischchan*), naked osman (*Gymnodiptychus dybowskii*), scaly osman (*Diptychus maculatus*), pike-perch (*Sander lucioperca*), freshwater bream (*Abramis brama*), tench (*Tinca tinca*) and common carp (*Cyprinus carpio*)] and stocking of Lake Issyk-Kul to increase fish supply.

During the 1930s, Lake Issyk-Kul produced about 1 000 tonnes of fish per year, which accounted for more than 80 percent of the fish harvested in the country. During the 1960s, a trout stocking program was developed in the lake, and a network of trout hatcheries and fish processing facilities saw lake-based production increase to 1 000 – 1 200 tonnes/annum (Alpiev *et al.*, 2013). During the USSR era, the trials to develop cage culture of trout on Lake Issyk-Kul failed, due to poor technical expertise and a lack of suitable feed sources. In 2005, rainbow trout cage culture was reintroduced, and in 2005 there were four companies operating rainbow trout farms on the lake (Corner, 2011). Between 2010 and 2016, the number of rainbow trout and carp farms increased from 53 to 267, while national fish production increased by almost 5.5 times (from 352 to 1 931 tonnes) (FAO, 2018).

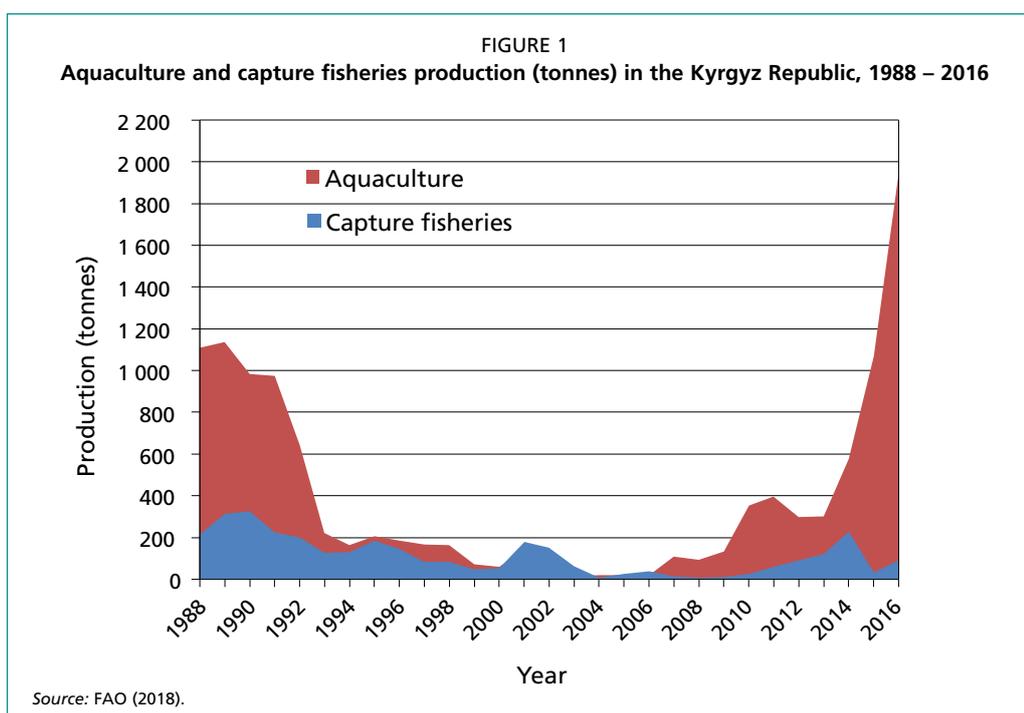
State assisted fisheries development in early 1950s supported the establishment of fish breeding facilities outside Issyk-Kul, Son Kul and Toktogul. The fish breeding facilities in Chui (opened in the late 1950s), Uzgen in Osh oblast (1968), and Talas (1975) gradually expanded pond production during the 1980s, producing over three-quarters of the total Kyrgyz fish production in 1989. During the 1980s, the technology

² Amu Darya trout (*Salmo trutta oxianus*) is endemic sub-species of sea trout (*Salmo trutta*) that occurs in the upper reaches of the Amu Darya and in its tributaries, the Kafirnigan and Surkhandarya rivers.

for breeding of cyprinids (e.g. silver carp, grass carp, common carp) was developed at Ton hatchery on the southern shores of the lake. Between 1966 and 1988, the hatchery produced more than 90 million fry and fingerlings of carps (silver carp, grass carp and common carp), freshwater bream, pike-perch, tench and Baikal omul (*Coregonus migratorius*). Most of this production was used to stock in the lake, and support the capture fishery.

The collapse of the USSR, disintegration of the state-lead economy and transition to the democratic state, negatively affected the fisheries sector in the Kyrgyz Republic. Aquaculture production markedly declined (Figure 1), and the transition probably impacted the fisheries sector more than other parts of the agriculture sector and the overall economy (Thorpe *et al.*, 2009; Thorpe and Van Anrooy, 2010). Reasons for the decline of fish production included cutbacks in funding, collapse of institutional and policy structure, a sharp increase in costs (particularly of imported feed), high customs tariffs and other trade barriers to feed ingredients and equipment imports, absence of subsidies, and experts leaving the country for better job elsewhere, in addition to poor ecological, social, economic and governance factors (Thorpe *et al.*, 2009; Thorpe and Van Anrooy, 2010).

The fisheries statistics presented in Figure 1 show that in the USSR era fish production was at a much higher level than it was following independence. After independence (1990) there was a marked decline in fish production, and in 2007 a slow increase began. Throughout the period (1988 – 2016), the share of total production accounted for by aquaculture exceeded the share accounted for by capture fisheries (Table 1).



3.2 Potential for growth of aquaculture

There are an estimated 1 533 ha of fish ponds in the Kyrgyz Republic, most of which are currently abandoned. The region around Lake Issyk-Kul, in the east of the country, is particularly promising for aquaculture development. During the USSR era, this region had approximately 600 ha of ponds. Many of these ponds have persisted, even though two thirds of them are currently abandoned.

There is good promising potential to rehabilitate the existing pond farms, and construct new production facilities. It has been estimated that production based solely on the existing pond infrastructure could yield up to 2 500 tonnes of fish per

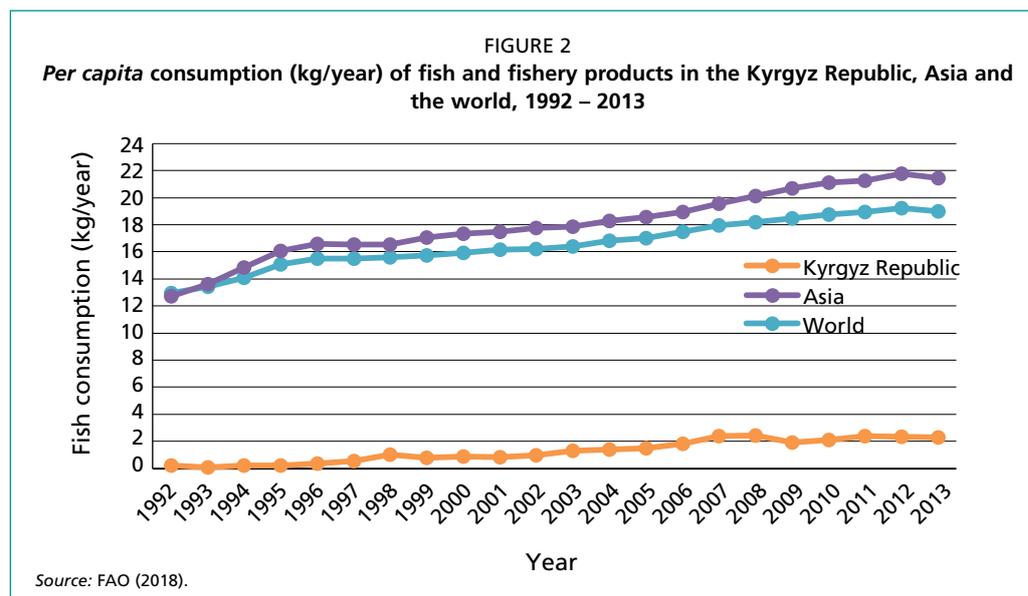
annum. Most of the ponds are in the Chui valley, near Lake Issyk-Kul, where climate (particularly the long growing season and warm water temperatures) are particularly good for fish production. In the Chui valley, it is possible to produce an average of 2 500–3 000 kg/ha of carps and trout in intensive and semi-intensive aquaculture (Sarieva *et al.*, 2008).

The main natural water bodies in the country are Lake Issyk-Kul which is the second largest mountain lake (and a world biosphere reserve), and Son Kul and Chatyr Kul, the country's second and third largest lakes. There are also more than 3 500 rivers and rivulets within six main river basins, and 13 large and more than 300 small artificial reservoirs on the Naryn, Chui and Talas rivers. All of these water bodies are potential sources of water for fish production in the Kyrgyz Republic (Thorpe *et al.*, 2009; Kustareva and Naseka, 2015).

Rehabilitating the production sector will require a combination of public and private sector support, and improvements in production technologies and efficiencies. With appropriate investment, it would also be possible to create highly profitable cage culture facilities on the cascade reservoirs of the Naryn river, and to establish trout farms in the country's extensive mountainous areas, where the biophysical environment is ideal for freshwater salmonids.

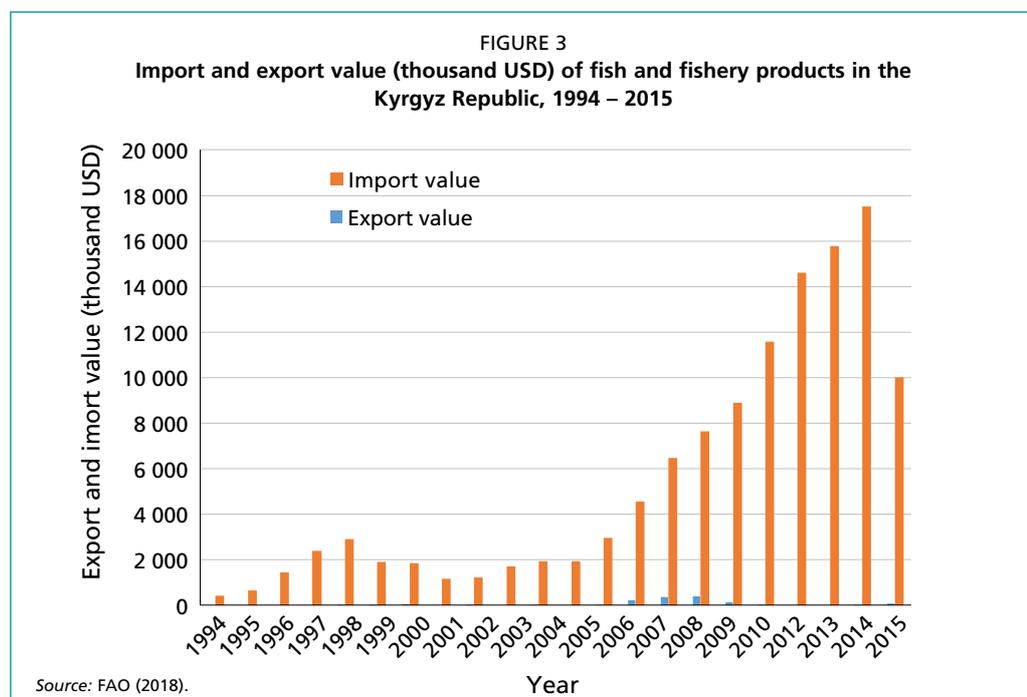
3.3 Fish consumption and increasing demand

Historically, the *per capita* fish consumption in the Kyrgyz Republic has been very low compared to the Asian and world averages (Figure 2). In 2013, the mean *per capita* annual fish consumption was only 2.31 kg in the Kyrgyz Republic, compared with 21.43 kg in Asia and 18.98 kg in the world. Nevertheless the *per capita* consumption has increased in the country between 2001 and 2013, as it has in Asia and the world as a whole (Figure 2). Demand for fish products in the Kyrgyz Republic is expected to increase further, due to population growth and rise in tourism (Mohammad R. Hasan, personal communication, 2017).



The value and quantity of fish imported into the Kyrgyz Republic have been, and currently are, much greater than the value and quantity of fish exported from the country (Figures 3 and 4). In most years between 1994 and 2015, there was no export of fish (Figures 3 and 4). In 2015, the country imported 7 062 tonnes of fish valued at USD 9.9 million, and produced 1 068 tonnes of fish were produced by aquaculture (FAO, 2018).

The increase in aquaculture production between 2010 and 2015, from 352 to 1 068 tonnes respectively (FAO, 2018), indicates there is clear scope for significant growth in aquaculture in the Kyrgyz Republic; growth, which can substitute for imports, and save significant amount of foreign exchange reserve.



3.4 Lack of quality feed as a constraint to production

In the Kyrgyz Republic, one of the main obstacles to fish production is lack of quality feed. Feed cost accounts for 65 – 75 percent of the total operational cost of production.

The number of feed ingredients that are available (whether locally sourced or imported) in the Kyrgyz Republic for use in fish feed manufacturing are reported in Table 2. The locally produced feed ingredients comprise grains (barley, maize, oat and

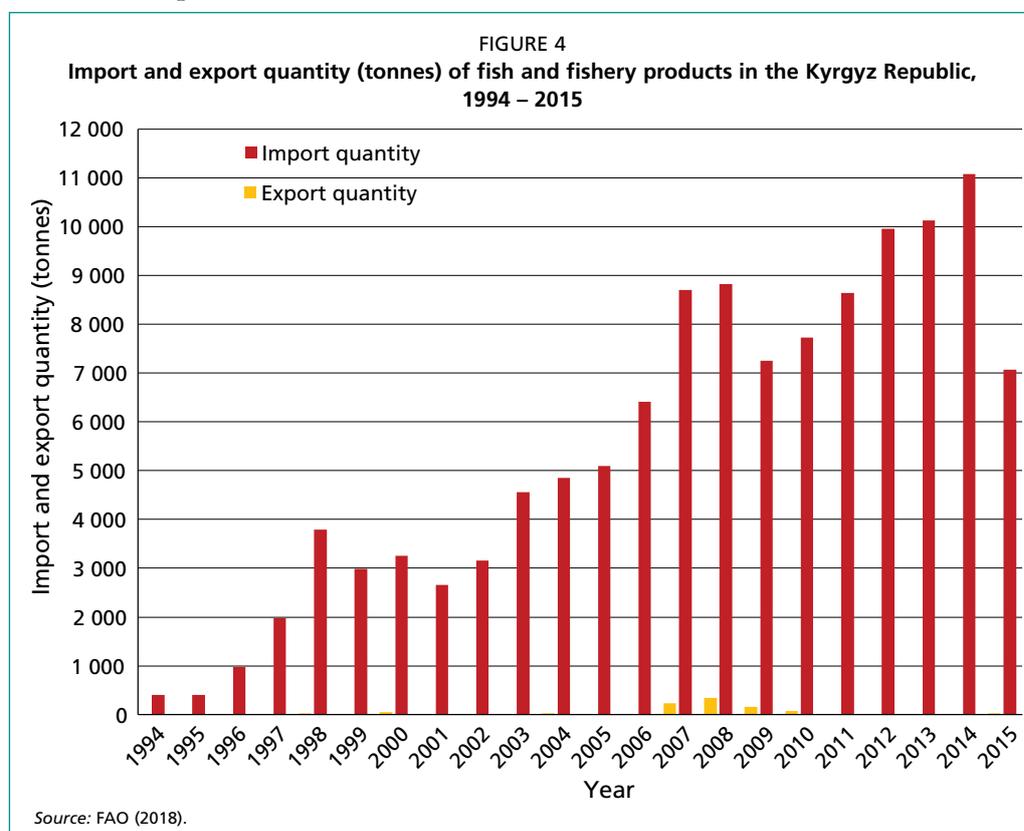
TABLE 2

Origin, processing method and cost of conventional feed ingredients available in the Kyrgyz Republic

Origin and ingredient	Processing method	Cost	
		KGS/kg	USD/kg
Kyrgyz Republic			
Barley	Milled	9	0.13
Clover	-	-	-
Corn flour		30	0.43
Maize meal	Milled	12–15	0.17–0.22
Oat meal	Milled	8	0.12
Sunflower meal/cake	Mechanically extracted	25	0.36
Wheat bran	Milled	8	0.12
Wheat flour	Milled	12–14	0.17–0.21
Imported			
Fishmeal	-	60	0.86
Meat & bone meal	-	30	0.44
Soybean meal/cake	Mechanically extracted	35 – 40	0.51 – 0.58
Sunflower oil	-	65	0.93
Vitamin & mineral mix	-	2 200	31.43

Source: 2016 Field Survey; KGS = Kyrgyzstani Som; 1 USD = 69.00 KGS.

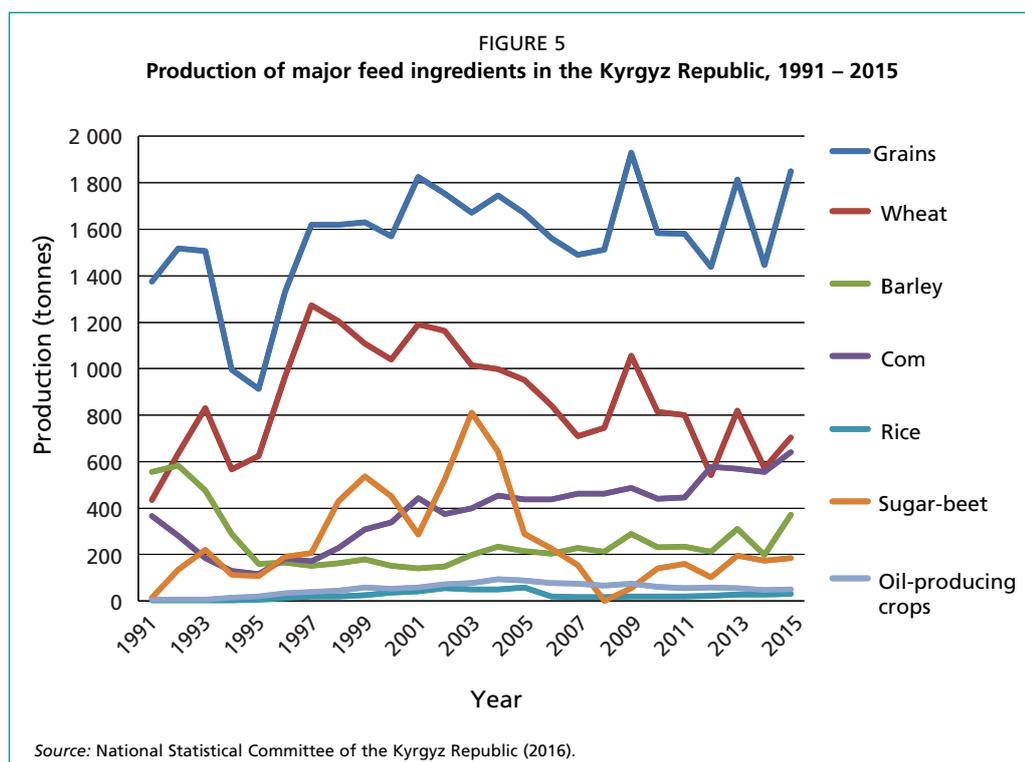
wheat) and other plant-based materials such as sunflower meal and clover (Table 2, Figure 5). The imported ingredients comprise animal protein sources such as fishmeal and meat & bone meal and plant protein source such as soybean meal. A vitamin and mineral mix, designed for poultry, is imported. The only lipid source reported as available is imported sunflower oil.



Many other ingredients have the potential to be used in fish (particularly carps and trout) feed, and in many cultured species, some of these ingredients are already used effectively. These other ingredients include: (i) terrestrial vertebrate animal by-product meals (meat meal, meat and bone meal, poultry by-product meal, hatchery and chicken eggs meals, blood meal), (ii) terrestrial and aquatic invertebrates (marine polychaetes, terrestrial worms, insect pupae/larvae, copepods), (iii) plant oil seed and pulse meals (whole or extracted oil seed meals, concentrates and isolates, such as soybean, rapeseed, sunflower, mustard, omega 3 fortified materials), (iv) brewing/fermentation meals (single cell protein such as algae, bacterial biomass, brewers and distillers grains), (v) cereal and flour milling products (middling, mill run bran, gluten from rice, wheat, maize, sorghum), (vi) agriculture wastes and products (fruit wastes, pulp cannery wastes, leaves, tubers, roots, kitchen scraps), and (vii) biofuel/ biodiesel byproduct (such as yeasts and distiller's dried grains with solubles (DDGS)).

For carp culture it is important to explore the organic and inorganic fertilizer resources of the country. Fertilization accounts for most of the natural productivity in ponds. Especially in Chinese carp culture, candidate species like silver carp heavily rely on the plankton population in the pond for their feeding and growth.

In addition, manures from livestock (horse, poultry, sheep, goat and swine) and imported inorganic fertilizers such as urea, triple super phosphate (TSP), and muriate of potash (MP), can also be used in fish production particularly in carp production. Thus, it is very clear that as the aquaculture sector grows in the Kyrgyz Republic, demand for these ingredients will increase, enhancing growth of the sector, as well as the backward and forward linkage of the aquaculture sector.



4. METHODOLOGY OF THE STUDY

4.1 Data collection and study area

Primary data was collected from different actors in the value chain by using qualitative and quantitative assessment tools comprising in-depth interviews using structured questionnaires (one for farmers/aquaculture producer and another for feed manufacturer and feed ingredient traders), and focus group discussions (FGD) and key informant interviews (KII) with semi-structured questionnaires.

The questionnaires were tested before being used in interviews with the carp and trout farmers, feed manufacturers, and feed traders. The participants for in-depth interviews were randomly selected. Most of the participants (n = 40, 73 percent) were aquaculture farmers; the remaining participants (n = 15, 27 percent) were feed manufacturers and feed ingredient traders who were also involved with livestock feed (Table 3).

The interviews with different value chain actors were conducted at their homes and/or farm sites; the duration of each interview was approximately 2 hours. The interviews

TABLE 3

Numbers of interviews for four categories of aquafeed value chain actors*

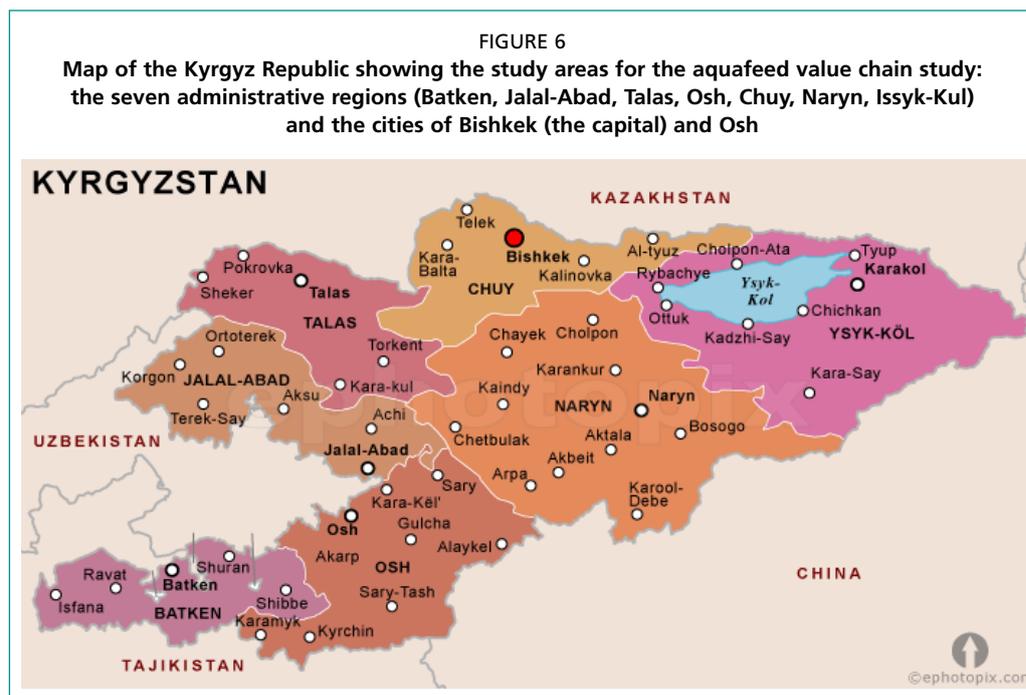
Categories of aquafeed value chain actors	Sample size	
	nos.	% of total
Farmer questionnaire		
Aquaculture farmer	40	73
Feed manufacturer/ingredient trader questionnaire		
Aquaculture/livestock feed wholesaler/importer/trader	5	9
Aquaculture/livestock feed retailer	5	9
Aquaculture/livestock feed miller	5	9
Total	55	100

* To supplement and validate the information in the in-depth questionnaires, interviews were also conducted with key informants (e.g. Director of the Department of Fisheries, lead farmers, private entrepreneurs, and national and international researcher working on this sector) in the Kyrgyz Republic.

focused on cost and return of the respective value chain activities, constraints, and suggestions about how to overcome those constraints.

The focus group discussions and key informant interviews (KII) were conducted with the officials from the Department of Pastures, Livestock and Fisheries (DPLF) of Ministry of Agriculture, Food Industry and Melioration (MoAFIM), FAO Kyrgyzstan staff, and association leaders.

The study was undertaken in all seven administrative regions (oblasts) and two cities in the Kyrgyz Republic where these actors were concentrated (Figure 6).



4.2 Value chain analysis (VCA)

The present study uses VCA as an assessment method for analyzing performance of the aquafeed value chain in the Kyrgyz Republic. According to Kaplinsky and Morris (2001) a value chain “describes the full range of activities which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use.”

A value chain consists of related actors who perform various activities to add value to a product in each link of the chain, from its primary production to its ultimate consumers. Value may be added to the product via activities such as production, processing, transporting, buying, and selling.

The VCA incorporates different sectoral backward and forward linkages, and in this way accounts for the dynamic linkages within, and among, various related sectors (Kaplinsky and Morris, 2001; UNIDO, 2009). There are two approaches to undertaking VCA: i) qualitative and ii) quantitative. In the present study we have used the qualitative and more descriptive approach, as emphasized by Kaplinsky and Morris (2001).

Value chain analysis was first popularized in the mid-1980s (Porter, 1985), and subsequently the analysis has been used for different purposes as advocated by Womack and Jones (1996), Gereffi, Humphrey and Sturgeon (2005), and many others. Initially it was used as an accounting/corporate analysis of complex manufacturing industries. Its use in development is more recent. The VCA approach can assess the relative importance of factors affecting competitiveness, the financial performance of different actors involved in the value chain, and identify the gaps/weaknesses, and

potential factors to upgrade and improve value chain performances (Macfadyen *et al.*, 2012). The VCA approach can also be used in assessment of the distributional impact, equity, and gender implications of any intervention (Mayoux and Mackie, 2008; Rubin, Manfre and Barrett, 2009; Gammage, 2009).

4.3 Profitability analysis

Data from the questionnaire surveys were coded, and entered into a Microsoft Excel spreadsheet. The statistical software 'STATA' was used to analyze the data, and to produce descriptive statistics.

To describe the aquafeed value chain (including production costs, returns and profitability of different actors in the chain), we used results from the data analyses, in combination with qualitative information collected through the in-depth questionnaire surveys, key informant interviews and field observations.

A profitability analysis was conducted to determine net returns of different value chain actors (Ahmed, Alam and Hasan, 2010). The analysis was based on: (i) the average price reported by different actors for their products and inputs, expressed in Kyrgyzstani Som (KGS) (1.00 USD = 69.00 KGS, November 2016), and (ii) average quantity purchased and sold, as reported by different actors for their outputs and inputs. The profitability analysis was based on the average of the cost and return of the value chain for the entire sample. In some cases where full cost and return data was not available for the entire sample, the average was taken from the available sample. The equations for calculating costs, returns, and profitability for different aquafeed value chain actors in the Kyrgyz Republic are shown in Table 4.

TABLE 4
Formulae for calculating costs, returns and profit margins of different value chain actors

Items	Formula used in this study
Costs	
Total cost (TC)	Variable cost + fixed cost
Variable cost (VC)	Cost for variable inputs
Fixed cost (FC)	Depreciation + interest + land use cost if any
Depreciation cost (DC)	[(Purchase price – salvage value)/total useful life]
Land use cost (LUC)	Rental value of land for enterprise in the time period
Returns and profit margins	
Gross return (GR)	Total production x market price
Net return (NR)	Gross return – total costs
Gross margin (income above variable costs) (GM)	Gross return – variable costs
Benefit cost ration (BCR)	Gross return/total costs

Source: Modified from Dillon and Hardaker (1989); Nix (2000); Ahmed, Alam and Hasan (2010).

4.4 SWOT analysis

To identify and evaluate the constraints and facilitating factors for developing a sustainable aquafeed sector in the Kyrgyz Republic, SWOT analysis was used. A SWOT analysis is a strategic planning tool comprising of two parts (FAO, 2006): 1. identify the internal condition (Strengths and Weaknesses) of an actor, (this part evaluates only actual strengths and weakness, not potential or expected strengths and weaknesses); and 2. identify the external conditions (Opportunities and Threats) of an actor, including the context (i.e. existing threats), as well as unexploited opportunities and probable trends.

The simplicity and ease of use mean that SWOT analysis has frequently been used. As a framework and strategic management tool, it has been widely adopted (Pickton

and Wright, 1998). Furthermore, SWOT analysis is an important approach for addressing some of the weaknesses of quantitative analyses.

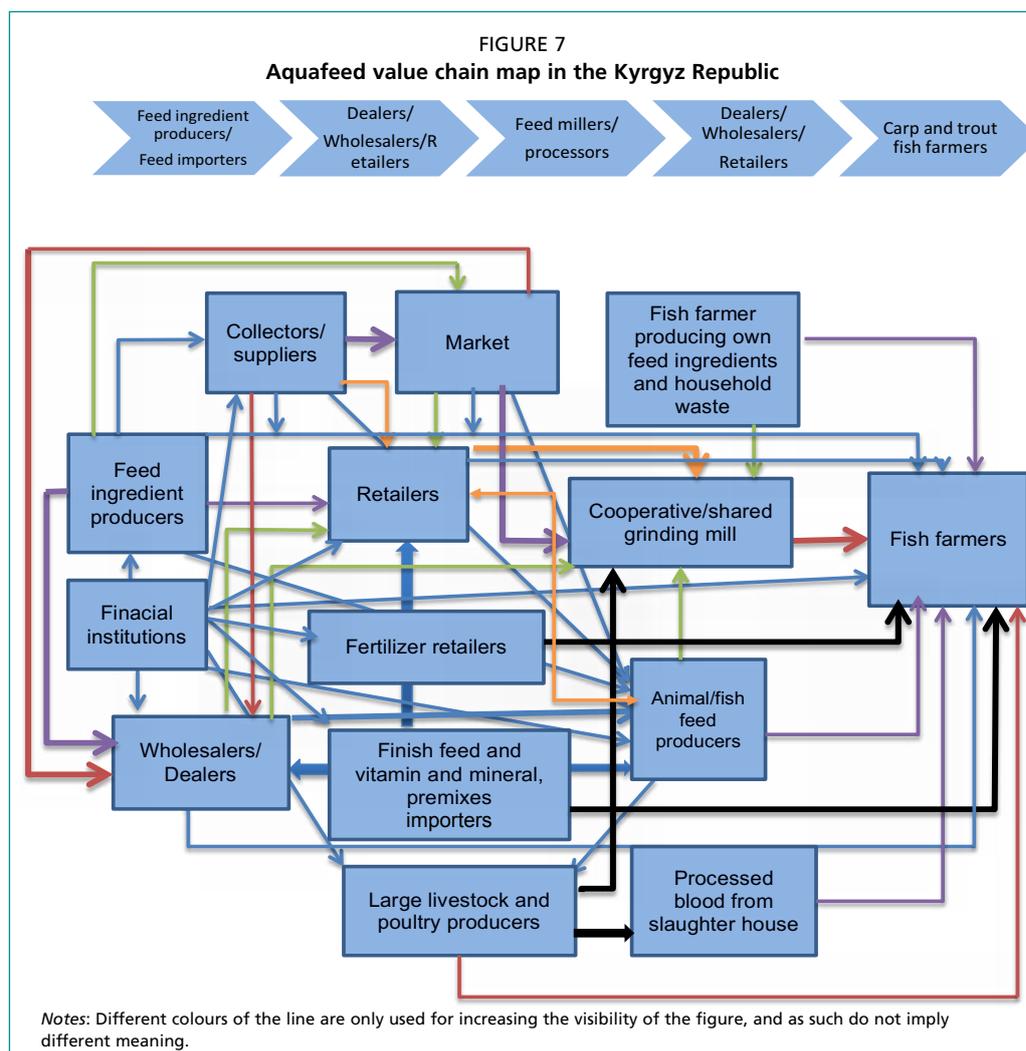
By identifying strengths, weaknesses, opportunities, and threats, it is possible to build strategies based on strengths, eliminate the weaknesses, and exploit the opportunities or use them to counter the threats (Yüksel and Dagdeviren, 2007; Armstrong and Kotler, 2011; Islam, 2016).

5. RESULTS AND DISCUSSION

5.1 Value chain mapping and marketing channels

One of the first tasks to complete in the VCA, is creating a map of the chain to trace the relationships between different actors (such as fish producers, feed and feed ingredients traders, feed manufacturers and importers), and the flow of inputs, services, and information through the chain (Figure 7). In the Kyrgyz Republic there is very little domestic aquafeed production, and thus the value-chain is short and simple. This situation contrasts with the complex aquafeed value-chains in some other countries, such as Bangladesh in South Asia, where the aquafeed sector is well developed.

The simplicity of the value chain in the Kyrgyz Republic is especially apparent for trout feed, since there is little domestic production. With exception of a few farmers producing their own feed, and one commercial feed mill near Bishkek producing erratic amount of trout feed, almost all the trout feeds sold in the Kyrgyz Republic are imported from Europe (primarily Aller Aqua in Finland and BioMar in Denmark), the Russian Federation and China, in 25 kg bags.



In contrast, the carp farmers in the Kyrgyz Republic mainly use farm-made feed, prepared using home produced, and domestically procured, feed ingredients purchased from feed traders in local markets. Carp farmers also use feed ingredients as fish feed after grinding it in grinding mill, and these ingredients are mostly produced by the farmers in their own land or sourced from the local market. Ingredients may be purchased directly from ingredients producers, from a local market, or sometimes from the wholesalers and retailers. Carp farmers sometimes use inorganic fertilizer to produce natural food in their ponds. These fertilizers are mostly purchased from fertilizer retailers in the market. The large farmers use additional feed supplements imported from outside of the country.

There is no value-addition, except transportation from the exporting countries to the Kyrgyz Republic, and the buying and selling functions. Sometimes the fish farmers or fish farmer associations import trout feed and distribute to their members/farmers. Trout farmers themselves also act as importers, when they buy their own feed from other countries. The importers also sell the imported feed to wholesalers as well as to retailers, who then continue the distribution through to the fish farmers. Eighty percent of trout feed is imported by the trout farmers themselves, and the remaining 20 percent is imported by various importers and sold through wholesale and retail feed chains.

The domestic feed millers buy most of their ingredients from within the Kyrgyz Republic, through various sources: collectors/suppliers, directly from the producers, from a bazaar/market, or from wholesalers and retailers. Wholesalers and retailers act as buyers and sellers of feed ingredients, as well as for finished feed. Most of the feed ingredients for producing fish and animal feed are available in the Kyrgyz Republic, the exception being the vitamins, minerals and premixes which are imported mostly from Europe, the Russian Federation and China.

Some of the major livestock and poultry producers in the Kyrgyz Republic import fish feed along with their animal feed, and sell it to the fish farmers. In addition, the fish farmers buy fresh blood (commonly used as an ingredient in fish feed), from slaughterhouses.

Carp and trout farmers sometimes use vitamin and mineral premixes and other feed additives as supplements, and buy these ingredients from the importers. Vitamins and mineral premixes and some other feed ingredients such as fishmeal, are imported by importers from the neighboring countries of Kazakhstan, the Russian Federation and China, and from more distant countries in Europe. Some of the feed ingredients and premixes arrive in the Kyrgyz Republic illegally via smuggling.

Only some of the influential actors in the aquafeed value chain in the Kyrgyz Republic have access to credit at their desired rate and amount from the financial institutions.

5.2 Value chain actors, value addition functions, and governance in the aquafeed value chain

The actors involved in the aquafeed chain in the Kyrgyz Republic are shown in Figure 7. The actors in the value chain perform functions or services for value addition in the chain, such as exchange functions (buying and selling), physical functions (transport, storage, processing), and facilitating functions (standardization, financing, risk-bearing, and market intelligence) (Kohls and Uhl, 2002).

Generally in contrast to the farm-made/semi-commercial feed, the commercial pelleted feed is produced in different sizes, depending on the fish growing stage such as starter, grower and finisher. Most of the actors involved in the aquafeed production and distribution channels perform several value addition activities, such as processing, manufacturing, storage, packaging, and transportation (Table 5), and receive a portion of the marketing margin. Their value addition functions are limited, due to the very simple chains.

TABLE 5
Value addition and linkages by different actors in the value chain

Actors	Value addition functions	Linkages
Feed and feed ingredient traders	Grinding, small quantity selling, packaging, storage, transportation, buying and selling	Backward linkages
Feed manufacturers	Feed processing and preparation, packaging, storage, buying, selling, transportation	Connector of backward and forward linkages
Fish farmers	Storage, feed use, buying, transportation	Forward linkages

Source: 2016 Field Survey.

Once the feed and feed ingredients have been produced or imported, there are no separate channels for feed for different species of fish and animals. All the actors produced and sold a mixture of fish and animal feed, with animal feed predominating.

The aquafeed value chain in the Kyrgyz Republic is governed by the producer driven chain, where the feed suppliers play a dominant role, involving a limited number of producer or importers/traders. The power relations among the actors are unequal because of the limited number of feed importers/producers while the number of buyers is numerous. Therefore, the price for feed is fixed (without any scope for bargaining among actors).

Information flow within the value chains is not transparent, because there are only a few feed importers, and they have monopoly power in the market. Furthermore, the spatial diversity among the regional administrations (oblasts) in the Kyrgyz Republic means that information flow from Bishkek, the capital to the seven oblasts is erratic. There are few legal restrictions on the quality of food products, and few law enforcement agencies that monitor the quality of food products in the Kyrgyz Republic. By extension, there is no system to check and monitor the quality of fish feed. The fish farmers and traders in the study reported that they were not aware of the existence of any standards for fish feed.

There are several, mainly governmental, institutions in the Kyrgyz Republic that are involved in or related to the aquafeed value chains, such as the Department of Pastures, Livestock and Fisheries (DPLF), Veterinary Inspection Council, Department of Certification and Registration, and the Center for Standardization and Metrology under the Ministry of Agriculture, Food Security and Land Reclamation. The DPLF is specifically responsible for fisheries and aquaculture activities such as extension services, quality, and inspection standards.

These institutions are supposed to support the sustainable development of the aquafeed value chain by providing extension services and technical support to value chain actors, however the institutions are ineffective due to lack of government finance and technical personnel. Furthermore, there are several national organizations such as the Institute of Biology of the National Academy of Science, and Independent Bread Inspection Laboratory, which are expected to provide support services for aquafeed quality assurance. However, these organizations are not effective either in supporting the aquafeed value chain, because they lack appropriate laboratory equipment necessary for providing such services.

Most actors reported that they perform their activity individually rather than within an association or organized group such as an association or cooperative. Although there are some community-based regional associations, such as the Trout Farmers' Association, they are mostly based in the in Chuy oblast, rather than throughout the country.

All the value chain actors expressed dissatisfaction with the services provided by most of the governmental organizations. Thus there is plenty of opportunity for

strengthening government organizations, as well as establishing new organizations that will facilitate the sustainable development of the aquafeed value chain to enhance fish production in the Kyrgyz Republic.

5.3 Regulatory, institutional and policy frameworks for aquafeed value chain development in the Kyrgyz Republic

The Kyrgyz Republic develops its fisheries development policy in accordance with particular national and international interests, and with the nature of the resources. The objective of the national fisheries policy is to manage the fisheries to ensure the sustainable use of the aquatic resources, with economic efficiency and broad social benefits.

The first comprehensive state program for the fisheries sector in the Kyrgyz Republic, after independence in 1991, was the 2005 ‘Sectoral Programme on Development of Fisheries in the Kyrgyz Republic for 2006 – 2010’ from the Department of Pastures, Livestock and Fisheries (DPLF), within the Ministry of Agriculture, Water Resources and Processing Industry (MAWRPI). Part of this programme for 2007 – 2008 was accepted by the government for financing (Kalnins and Joldubaeva, 2008).

In 2007, DPLF prepared the “Strategy for Fisheries and Aquaculture Sector Development and Management in the Kyrgyz Republic (2008 – 2012)” (Sarieva *et al.*, 2008). The strategy, outlining development of the sector, was prepared with input from many fisheries and aquaculture sector stakeholder groups, and with support from the European Commission (EC), and from FAO under the Project EC/FAO Facility GCP/GLO/162/EC– Kyrgyzstan “Development of inland fisheries and aquaculture in the Kyrgyz Republic to reduce rural food insecurity” (Sarieva *et al.*, 2008). This 2007 strategic plan was one of the most comprehensive strategic policy documents designed specifically to develop the fisheries sector in the Kyrgyz Republic. There has not been any subsequent plan, thus the 2007 strategy is being used.

The five development objectives stated in the strategy are, according to Sarieva *et al.* (2008):

- Review and update fishery legislation to introduce reforms enabling modern fishery and aquaculture management and development.
- Ensure the protection and responsible management of fishery resources.
- Ensure the implementation and further development of the restocking program.
- Develop diversified and multipurpose fisheries and aquaculture enterprises.
- Improve the market supply chain and processing of fishery products, and ensure the safety and quality of these products.

The management and regulation of fisheries in the Kyrgyz Republic is very complex. The legislations, policies and institutions related to aquaculture and the aquafeed value chain enacted during and after the 1990s, consider the prospects for passage, implementation, enforcement, effectiveness, gaps, and compliance with international and regional agreements. Policies on the management of the fisheries resources mirror the policies for management of natural resources and environmental conservation.

The measures necessary to conserve the fishery resources in natural water bodies are contained in the constitution of the Kyrgyz Republic, the Criminal Code of the Kyrgyz Republic, Laws on Conservation of Fisheries, and a number of other regulatory acts and papers (Kustareva and Naseka, 2015). The fisheries sector is administered by the law on “Fish Industry”, 1997³. Other important items of legislations related to the sector are “Veterinary Law”, laws on “Natural Areas of Preferential Protection”, “Environmental Assessment”, “Biosphere Territories”, “Fauna”, “Environmental Protection” and “The Water Code”.

³ This law including its amendments is considered as the main body of the legislative framework for the fisheries sector in the Kyrgyz Republic.

TABLE 6
List of institutions/departments related to aquaculture and aquafeed

Name	Roles
Government institutions/agencies	
Ministry	
Agriculture, Food Security and Land Reclamation	Development and administration of the agricultural sector. Ministry has 16 specialized subordinated agencies, supervises three scientific research institutes, and oversees 17 agro-industrial sectors including the fisheries sector.
Ecology and Emergency	Monitors aquatic environments and ecological conditions.
Economy and Finance	Focuses on development and implementation of taxation in the agricultural sector, developing the mechanism of agricultural credit and insurance, rural finance and investments.
Education and Science	Plays a vital role in agricultural education, including fisheries, by developing the curricula and providing financial support to students.
Environment and Emergency Situations	Focuses on biodiversity issues, water supply and treatment, sustainable use of natural resources, and land improvement.
Health	On epidemiological issues, general health of all population and food safety.
Industry, Trade and Tourism	Focuses on development of exports of agricultural produce, investments into local input producing industries and promote tourism.
Transport and Communication	Development of information and communication infrastructure.
Agency, Department, and Directorate	
State Agency on Environment and Forestry	Issues licenses for private and joint stock companies to carry out commercial fishing and fisheries inspection.
Department of Pastures, Livestock and Fisheries	Development and management of the fisheries sector. Records the national fish catch, and conducts state fisheries policy (including the organization and regulation of both capture fisheries and aquaculture). Registration and monitoring of fish farms.
Directorate of the Biosphere Reserve	Controls access and manage activities of fisheries inspectors and carries out educational work.
Laboratory	
Independent Bread Inspection Laboratory	Proximate composition of feed ingredients and feeds.
National Academy of Sciences	
Fisheries Research Centre for Ichthyology and Hydrobiology	Conducts aquatic research.
Institute of Biosphere, Scientific Center of Fisheries	Conducts aquatic research.
The Issyk-Kul Biological Station of the Institute for Biology and Soil	Conducts fisheries and aquaculture research, controls the state of forage reserves, fish populations, and their natural reproduction.
Academia	
Department of Biology, Karakol University	Study and research related to fisheries.
Department of Biology and Zoology, Kyrgyz State National University	Study and research related to fisheries.
Department of Ecology, Kyrgyz Agriculture Academy	Study and research related to fisheries.
Department of Fishery, Kyrgyz Agriculture Technical School	Study and research related to fisheries.
Institute of Ecology and Nature Management, Kyrgyz State University of Ishenaly Arabaev	Study and research related to fisheries.
Associations	
Hunting and Fishing Union	Acts as a platform of hunters and recreational and small-scale fishers. Members receive the right to fish as amateurs and for recreation, and non-members can buy a day license.
Kyrgyz Association of Pisciculturists	Coordinates the activities and protects the interests of fish farms and their members, and provides legal, informational and other services to the members.

Note: All institutions are located in Bishkek, except the Issyk-Kul Biological Station.

Sources: Sarieva et al. (2008); Mirzabaev et al. (2009); Kustareva and Naseka (2015).

When the Kyrgyz Republic became independent in 1991, fisheries were included in the Republican Industrial Association *Kyrgyzrybhoz* (later renamed *Kyrgyzbalygy*) under the Agro-industrial Committee. Since the creation of the DPLF in 1997, (in the wake of the Fisheries Law under the Ministry of Agriculture, Water Resources and Processing Industry (MAWRPI)), the DPLF has been abolished and restructured several times (Sarieva *et al.*, 2008). In 2016, the DPLF was restructured with several administrative units to form a single department.

Although there are multiple policies, regulations and institutions in the Kyrgyz Republic that deal with the issues of aquaculture and aquafeed, most of them are not up-to-date, are not compliant with international standard, and they are not working according to their mandates. These limitations are mostly due to lack of funding, and lack of enforcement infrastructure and mechanisms. Furthermore, the policies, regulations and institutions for fisheries and aquaculture development, are not highly coordinated, and their work is sometimes duplicated within and among the organizations. Virtually no monitoring or scientific research is being done, and no authority or institution has any experience in the aquafeed value chain in the Kyrgyz Republic.

There is an urgent need for a more integrated and consistent approach, of an international standard, to fisheries and aquaculture in the Kyrgyz Republic and their value chain management at the policies, regulations and institutional levels. New laws, institutions and policies or modifications of the existing policies, regulations and institutions are necessary for sustainable development of fisheries and aquaculture development in the Kyrgyz Republic.

5.4 Cost and return analysis of value chain actors

Cost and return analysis was undertaken for each of the actors to estimate the gross profit secured by each actor. All the value chain actors require significant investment, both for initial infrastructure and machinery set-up, and for subsequent running expenditures with which to operate the business. Skilled labor and professional management are also necessary for establishing and running the enterprises.

During the study, it was difficult to obtain sufficient information for calculating cost and return analysis for all the actors, particularly information about capital investment. Very few actors provided full details of the cost and return of their businesses, and many provided only scattered information on the operational expenses, expressed only as a percentage of total running costs. This limited information is all that was available when trying to provide the overview of profitability of different actors in the aquafeed value chain in the Kyrgyz Republic.

5.4.1 Profitability analysis of feed millers

Most fish feeds in the Kyrgyz Republic are imported. The minority are produced by the private sector and fish farmers themselves. There is no official data on current volume of aquafeed production or on the number of feed mills.

Per unit production cost of aquafeed and animal feed for three kind of mills are presented in Table 7. In all three kinds of feed mills, among the variable cost, feed ingredients costs dominate (85 to 95 percent), followed by labor and electricity costs.

Profitability analysis (gross margin, net return and BCR) shows that both the animal feed and aquafeed businesses are profitable. The medium-scale fish feed mill, which mostly produces trout feed, earns a higher profit than does the small fish feed mill, which produces mostly carp feed. For the medium-scale animal feed mill, the net return and gross margin indicate profit but not as much as that of the small- and medium-scale aquafeed producers (Table 7).

To increase efficiency and reduce the production cost of feed mill, alternate less expensive feed ingredients must be sought; cheaper ingredients will reduce cost and price of feed, and benefit the fish and animal producers in the country.

TABLE 7
Cost and return for producing 1 kg of fish and animal feed for three different kind of feed mills in the Kyrgyz Republic

	Small-scale/semi-commercial fish feed mill ^{a)} (feed mostly used for own farming)		Medium-scale fish mill ^{b)} (feed used for own farming, and sale to other customers)		Medium-scale animal feed mill (feed used for sale to other customers)	
	Total value (KGS/kg)	Shares of total cost (%)	Total value (KGS/kg)	Shares of total cost (%)	Total value (KGS/kg)	Shares of total cost (%)
VARIABLE COSTS						
Labor and management	0.64	1.42	3.20	3.76	0.48	2.40
Feed ingredients ^{c)}	43.05	95.67	72.50	85.29	18.00	90.00
Repair and maintenance	0.07	0.16	0.69	3.76	0.14	0.70
Transportation and storage	0.07	1.42	0.83	3.76	0.16	0.80
Electricity and fuel	0.44	0.98	3.78	4.45	0.20	1.00
Taxes	0.24	0.53	1.20	1.41	0.33	1.65
Miscellaneous costs	0.24	0.53	0.80	0.94	0.33	1.65
A. Total variable costs	44.75	99.44	83.00	97.65	19.64	98.20
FIXED COSTS						
Depreciation ^{d)}	0.05	0.11	0.90	1.06	0.17	0.85
Land use/rental costs	0.20	0.44	1.10	1.29	0.19	0.95
B. Total fixed costs	0.25	0.56	2.00	2.35	0.36	1.80
TOTAL COSTS						
C. Total cost (TC)	45.00	100.00	85.00	100.00	20.00	100.00
RETURNS AND BENEFITS						
D. Total return from output	50.00	-	100.00	-	22.00	-
E. Gross margin (D - A)	5.25	-	17.00	-	2.36	-
F. Benefit cost ratio (D/C)	1.10	-	1.20	-	1.10	-
G. Net return (NR) (D - C)	5.00	-	15.00	-	2.00	-
ANNUAL PRODUCTION						
Average annual production (tonne)	50		100		30 000	

Notes: a) produces mostly carp feed and some trout feed; b) produces trout feed; c) variable costs include feed ingredients, premixes and additives; d) depreciation is calculated by straight-line method, assuming 15 years as time period. The exchange rate in 2016 is USD1.00 = 68 Kyrgyzstani Som (KGS).

Sources: 2016 Field Survey.

5.4.2 Profitability analysis of feed and feed ingredient wholesalers and retailers

The profitability of feed and feed ingredient wholesalers and retailers is shown in Table 8. The major share of the cost of their business is purchase of ingredients (about 95 percent), followed by the cost of labor and management. Both wholesalers and retailers earn profit from their business; while the wholesalers' average sale quantity per day or per month is higher than that of the retailers, the retailers earn more profit than the wholesalers because the profit margin of the retailers are generally higher than that of the wholesalers. The businesses typically have a high percentage of variable costs, comprising feed and feed ingredients purchases (with other operational costs being primarily for transport, electricity and rent), and low fixed cost. The above information suggests that as long as wholesalers and retailers can sell their product for a small standard margin over and above the purchase price, there is little risk inherent in the business. Typical wholesale and retail shops for feed and feed ingredients in the Kyrgyz Republic are shown in Figures 8 and 9.

TABLE 8
Costs and return of input and output of feed for wholesalers and retailers

Items	Wholesaler		Retailer	
	Total value (KGS/tonne)	Shares of total cost (%)	Total value (KGS/tonne)	Shares of total cost (%)
VARIABLE COSTS				
Labor and management	300	1.20	300	0.91
Feed ingredients ^{a)}	23 714	94.92	32 000	96.59
Electricity and fuel	100	0.40	50	0.15
Other cost (e.g. transport, license)	500	2.00	500	1.51
A. Total variable cost	24 614	98.52	32 850	99.15
FIXED COSTS				
Depreciation ^{b)}	50	0.20	30	0.09
Land use/rental costs	320	1.28	250	0.75
B. Total fixed costs (TFC)	370	1.48	280	0.85
TOTAL COSTS				
C. Total cost (TC)	24 984	100.00	33 130	100.00
RETURNS AND BENEFITS				
D. Total return from output (TR)	27 000	-	36 000	-
E. Gross margin ^{c)} (D – A)	2 386	-	3 150	-
F. Benefit cost ratio (D/C)	1.08	-	1.09	-
G. Net return (NR) (D – C)	2 016	-	2 870	-
DAILY SALES				
Average daily sale (tonne)		2		1

Note: a) including premixes and additives; b) depreciation calculated by straight-line method, assuming a 10 year the time period; c) income above variable cost.

Sources: 2016 Field Survey.

FIGURE 8
Wholesale feed and feed ingredient shop



FIGURE 9
Retail feed and feed ingredient shop



5.4.3 Profitability analysis of rainbow trout and carp farmers

The average cost and returns data (i.e. financial performance) for producing 1 kg of rainbow trout and carp in the Kyrgyz Republic are shown in Table 9. There is positive financial performance in both types of farms, in terms of net profit and in gross margin per kilogram of fish.

Rainbow trout farming is the dominating aquaculture practice in the Kyrgyz Republic, and this fish is popular among consumers. The comparative per unit price of rainbow trout is higher than that of carp, and production cost is also higher than that of carp.

TABLE 9
Costs and return for production of 1 kg rainbow trout and carps

Items	Rainbow trout		Carps	
	Total value (KGS/kg)	Shares of total cost (%)	Total value (KGS/kg)	Shares of total cost (%)
VARIABLE COSTS				
Total labor and management	36.00	17.35	30.00	27.87
Fingerling	12.00	5.78	5.00	4.64
Feed	156.00	75.20	70.00	65.03
Miscellaneous costs (e.g. transport, electricity)	2.50	1.21	2.00	1.86
A. Total variable cost	206.50	99.54	107.00	99.40
FIXED COSTS				
Depreciation ^{a)}	0.45	0.22	0.28	0.26
Land use costs	0.50	0.24	0.37	0.34
B. Total fixed cost (TFC)	0.95	0.46	0.65	0.60
TOTAL COSTS				
C. Total cost (TC)	207.45	100.00	107.65	100.00
RETURNS AND BENEFITS				
D. Total return from output (TR)	300.00	-	200.00	-
E. Gross margin (income above variable cost) (D – A) ^{b)}	93.50	-	93.00	-
F. Benefit cost ratio (D/C) ^{c)} (undiscounted)	1.45	-	1.86	-
G. Net return (NR)	92.55	-	92.35	-
FEED CONVERSION RATIO				
Feed conversion ratio (FCR) ^{d)}	1:1	-	1:2	-

Notes: a) depreciation calculated by straight-line method, assuming a 10 year the time period; b) income above variable cost; c) undiscounted; d) FCR is calculated from the kg of dry feed that is used to produce 1 kg of live fish.

Source: 2016 Field Survey.

Feed cost comprises the highest percentage (65 – 75 percent) of the operation cost for both trout and carp farming. Feed cost for trout farming (about 75 percent of the total cost) is higher than that for carp farming (about 65 percent of the total cost). Labor and management cost constitutes the next most important input (17 – 27 percent) followed by purchase of fingerlings (4 – 5 percent). Fixed costs are low due to the nature of the fish farming business, and also because many farms are on rented land, which decreases the incentive for farmers to invest in fixed assets. The average feed conversion ratio for carp (≥ 3.00) is double than that of rainbow trout (≤ 1.50), as the carp farmers often use farm-made feed, while the trout farmers mostly use nutritionally balanced industrially produced pelleted feed. The feed is produced by mixing different domestically produced feed ingredients, sometimes mixed with vitamin and mineral premixes and other additives.

A large commercial rainbow trout farm (with raceways with a feed storage facility), and a typical carp farm with earthen ponds in the Kyrgyz Republic are illustrated in Figures 10 and 11 respectively.

FIGURE 10
A large rainbow trout farm with raceways (left) and a feed storage facility (right)



FIGURE 11
A typical carp farm with an earthen pond



5.5 SWOT analysis of aquafeed value chain development in the Kyrgyz Republic

The SWOT as a situation analysis allowed identification of key issues relating to development of a sustainable aquafeed sub-sector in the Kyrgyz Republic. The analysis provides the sub-sector's strengths and successes, and its limiting factors. The SWOT analysis presented in Table 10 is based on stakeholder interactions, field observations, in-depth farm surveys, and a literature review.

The analysis explored how the aquafeed value chain performance could be improved by identifying the critical factors affecting chain performance. All of the issues identified by the SWOT analysis represent potential areas within the value chain, and relevant external factors (for example policy makers, research organizations, and extension agents) to which intervention can be applied to improve value chain performance.

5.6 Factors affecting aquafeed value chain efficiency

In addition to identification by SWOT analysis, numerous factors constraining the development of aquafeed value-chain were identified by interviewing using the questionnaire, focus group discussions (FGD) and key informant interviews (KII) with different value chain actors. A summary of the key constraints faced by different aquafeed value chain actors is presented in Table 11. All of the factors represent potential areas of action to improve the aquafeed value-chain performance by the value-chain actors, and by those relevant stakeholders outside of it (such as government, donor organizations, national and international organizations).

TABLE 10
SWOT analysis of the aquafeed value chain in the Kyrgyz Republic

Strengths (S)	Weaknesses (W)
<p>Aquaculture development is already on the nation's policy agenda</p> <p>Availability of domestically produced feed ingredients</p> <p>Clean mountain water flow</p> <p>Plenty of unused lakes, reservoirs, ponds and open water suitable for aquaculture</p> <p>Relatively efficient and complementary use of land and water resources</p> <p>Fish can provide nutritional benefit to Kyrgyz households</p> <p>Gender equitable employment opportunities including family labour</p> <p>Availability of international institutional support such as FAO, WFP, UNDP</p> <p>Different government organizations related to fisheries and aquaculture development such as DPLF, and a veterinary inspection department</p> <p>Availability of cheap labor in the economy</p> <p>Cheap electricity supply</p> <p>Availability of major ingredients for feeds</p>	<p>No national policy strategy has been defined for aquaculture and aquafeed development</p> <p>Uncoordinated initiatives by different authorities</p> <p>Unclear and ambiguous legislation</p> <p>Initial investment costs for feed mill are very high</p> <p>Very poor planning/coordination of water management issues</p> <p>Aquafeed value chain requires greater technical knowledge and skills than other agricultural value chain</p> <p>A lack of efficient and motivated expertise, resources, budget, and equipment in public agencies</p> <p>Lack of timely availability and quality of fingerlings</p> <p>Lack of post-harvest processing and storage facilities</p> <p>Inadequate and underdeveloped infrastructure (e.g. markets, roads)</p> <p>High costs of transportation</p> <p>Challenging bio-physical conditions in the Kyrgyz Republic</p> <p>Monopoly in import of fingerlings and commercial feed</p> <p>Underdeveloped domestic machinery and spare parts market</p> <p>Demand for fish and aquafeed is very low</p> <p>Seasonality of production</p> <p>Aquafarmers lack of knowledge about aquafeed's positive benefits</p> <p>Unavailability of some of the costly feed ingredients and additives</p> <p>Underdeveloped education system for producing competent human capital</p> <p>Government bureaucracy</p> <p>Limited technology</p> <p>Limited R&D capability</p> <p>High mortality of fish due to disease which may reduce the overall fish production</p> <p>Gaps in documented data.</p>
Opportunities (O)	Threats (T)
<p>Provides opportunity to obtain financial and technical assistance from international donors to enhance the capacity of public organizations and related human resources</p> <p>Offers sustainable future increases in fish yield and production, and production may again be as high as, or exceed, that during the USSR era</p> <p>Provides opportunity to develop backward linkages to agricultural sectors such as wheat, maize, and barley</p> <p>Creates more employment opportunities (women and adult family labor), and increasing incomes and livelihood options</p> <p>Improves food and nutritional security</p> <p>Would make use of the agricultural extension system</p> <p>Would make optimal use of increasingly scarce land and water resources</p> <p>Would help to meet future demand for fish consumption</p> <p>Would be possible to introduce innovation into the aquafeed value chain, such as improvements to genetic potential and management practices of fish, more innovative and nutrient enriched feed production</p> <p>Import substitution of feed and some feed ingredients</p> <p>Domestic market expansion of feed, feed ingredients, machine and spare parts</p>	<p>Risk and uncertainty related to climate variability, and related flooding and drought</p> <p>Risk of losses due to theft, disease, and predators such as snakes and crabs</p> <p>Unfavorable weather condition during the long winter</p> <p>High production costs</p> <p>Competitive neighbor and import from other countries</p> <p>Illegal import of feed, feed ingredients and other necessary ingredients for aquafeed value chain</p> <p>Insufficient educational levels particularly technical education among different value chain actors</p> <p>Ineffective agricultural extension services</p> <p>Limited access to timely credit, high interest rates, and unfavorable loan repayment schedules</p> <p>Somewhat negative attitudes of societies towards fish consumption</p> <p>Markets– unfavorable prices and competition</p> <p>International trade issues</p> <p>Increasing cost of production</p> <p>The entry of the Kyrgyz Republic into the customs union</p> <p>Dependency on imported fertilized fish eggs</p>

Sources: Personal stakeholder interactions, key informant interviews (KII), field observation, in-depth questionnaire survey and literature review of Mikkola (2012); FAO (2014); Kustareva and Naseka (2015).

TABLE 11

Overview of critical factors hindering aquafeed sector development in the Kyrgyz Republic, according to different value chain actors**1. Feed and feed ingredient traders, suppliers, and producers**

- All feed ingredients are not available year round, due to the seasonality of production.
- Irregular supply of electricity.
- No storage facility in the wholesale and retail markets.
- Most entrepreneurs do not have prior knowledge, particularly technical knowledge of feed and feed ingredients in general, and business in particular.
- Bank interest rate for lending money to agricultural business is nearly 10 percent, which is considered very high.
- The selling place/shop/markets are in poor condition, and are not well decorated. This is problematic in wet, hot and cold weather.
- No quality control facility is available for feed and feed ingredients analysis.

2. Feed millers

- High value added tax (VAT) for import of feed ingredients from custom union member countries.
- No VAT for importing the final products such as fish, eggs and feed.
- Import process is very complicated.
- Absence of local knowledge on feed formulation.
- Due to small aquaculture sector, feed demand is very low, and most of the farmers (particularly carp farmers) use farm made feed.
- Kyrgyz currency exchange rates are volatile, and the Kyrgyz som (KGS) is often devaluated.
- No government support for aquaculture and aquafeed sectors in the Kyrgyz Republic compared to Kazakhstan where there is extensive government support..
- High production cost compared to neighboring countries.
- Feed and feed ingredients are mostly imported from Poland, Denmark, Russian Federation and Netherlands. For domestic producers, it is very difficult to compete with the imported products.
- Main ingredients of fish feed are fishmeal and fish oil, and fishmeal is not domestically produced in the Kyrgyz Republic. The Kyrgyz manufacturer have to depend on imports from other countries, mainly from Russian Federation and countries in Europe.
- Quality of imported feed ingredients is not always good.
- Smuggling of feeds and feed ingredients from neighboring countries, particularly Kazakhstan. In Kazakhstan the production cost is very low, and thus competition is difficult. The customs union precludes the Kyrgyz government from regulating feed price, thus hindering protection of the domestic industry.
- Seasonality in fish production. February to August is peak season, while winter-autumn is the low season for feed business because of low demand for feed.
- Government bureaucracy is quite complex, thus much time often spent to obtaining the necessary certificates (e.g. Kyrgyz standard certificate) and permissions.
- Machinery and spare parts are scarce in the Kyrgyz Republic, and supplies must therefore be imported.
- Feed mill needs high voltage electricity, which requires high voltage transformers, requiring substantial financial investment.
- Some feed ingredients have to be imported; for example from Kazakhstan, however the quality is not always good.
- Most of the fish producers perceived that locally produced feed is of poor quality.

3. Fish farmers

- Feed price is very high, and availability of feed in the local market is erratic.
- Awareness among farmers of the benefits of commercial feeds is commonly lacking.
- Transport cost is very high.
- Cold weather, strong sunlight, and poor water quality, reduce feed consumption by the fish.
- Water pollution and diseases are the main problem in production.
- Market price of fish is often low compare to livestock products, which sometimes discourages farmers from cultivating fish.
- Imported marine fish is very cheap, and domestic producers therefore cannot compete.
- Main problem is lack of money. Interest rate for a bank loan is very high, which discourages entrepreneurs from investing in the aquaculture sector.
- Feed price in the market is very high. If farmers buy the market feed, they cannot make a profit. Moreover, there is little confidence in the quality of feed in the market.
- Vitamin and premixes are not available in the Kyrgyz Republic.
- In the Kyrgyz Republic, demand for fish is very low, with consumption being typically only once per month. Consequently, there is a low demand for aquafeed.
- Carp is not a favoured fish, due to its small size and numerous bones.

TABLE 11 (CONTINUED)

3. Fish farmers
<ul style="list-style-type: none"> - The price, particularly for carp, is very low. Therefore farmers do not want to buy expensive feed from the market, and instead they use semi-commercial feed produced by small-scale feed mill or farm-made feed. - There are no industrial feed manufacturers in the Kyrgyz Republic; most fish farmers use semi-commercial/farm-made feed, and the minority use imported feed. - There is no fingerling production in the Kyrgyz Republic. Young fish are raised from imported hatching eggs, for which the mortality rate is very high. - There is lack of specialists and technical knowledge. Currently Aqua Service (a cooperative organization) provides training, but a proper agency is needed to train feed manufacturers and fish farmers. - Fish farmers in the Kyrgyz Republic have recently noticed that the aquaculture sector is affected by several fish diseases, but they do not have technical personnel to detect the diseases, nor to suggest proper remedies. - Lack of public investment is also a major problem. Currently the Kyrgyz government does not invest money in developing the aquaculture sector. - There is a demand for low price and high quality feed, however this is not available in the Kyrgyz Republic. - Price varies with fish size though, restaurants or cafés prefer small fish. - Illegal fish catching is a significant problem. - Fish statistics, including for capture and culture production, are not well updated, and may be inaccurate. Information on species number for capture and culture fisheries, and lake production is absent, or outdated. - Political instability in the country is a major problem. - Carp are imported from the neighboring country of Kazakhstan. The imported carps are cheaper than domestically produced carps, and thus the domestic producer cannot compete with the cheap import. - Very high feed conversion ratio (FCR) of domestically produced fish feed. - Sub-standard on-farm storage of feeds and feed ingredients in most fish farms. - General scarcity of carp feed in the market. - Fish yield is often very low, which ultimately gives low returns to the farmers, which eventually results in low cash flow.
4. Common for all actors
<ul style="list-style-type: none"> - Poor physical infrastructure. - Poor storage facilities. - Lack of well-organized marketing outlets. - Lack of appropriate transport facilities. - Fluctuation in prices. - Social factors including negative preferences and attitudes towards fish. - Low-income levels. - Lack of available statistics on technology, management practices and consumer preferences. - Lack of proper institutions, regulations and policy. - Lack of credit. - Poor coverage and quality of extension services. - Inadequate linkages between research and development (R&D) institutions and farmers, such that research outputs and outcomes are not operationalized by the farmers and other actors in the chain. - Poor distribution network throughout the country.

Source: 2016 Field Survey.

6. CONCLUSION AND RECOMMENDATIONS

This study demonstrated that the nascent Kyrgyz aquafeed value-chain is relatively simple, including only four main stakeholder groups: feed ingredient traders, aquafeed producers, aquafeed and feed ingredient traders, and fish farmers. Although this sub-sector is not labor-intensive, it has the potential to generate considerable levels of value-addition, resulting in profitable businesses at each stage of the value-chain, and provision of employment for many people, including women, in different segments of the value chain.

The strengths of this sector, coupled with the constraints threatening its performance and sustainability, and the enormous opportunities for further improvements in value-chain performance, provides a strong argument for action by different actors within the value-chain, by national and international organizations, and by the government in the form of supportive policy institutions and regulations (such as quality control, licensing, infrastructure, and human capacity development).

Based on the findings of this study, there are seven key recommendations for sustainable development of the aquafeed value chain in the Kyrgyz Republic. The recommendations are as follows:

Increase demand for fish

Average annual *per capita* consumption of fish in the Kyrgyz Republic is extremely low about 2.3 kg *per capita* in 2013 compared to the world average annual *per capita* consumption of 19.0 kg. Fish, particularly trout, is a luxury product in the Kyrgyz Republic, and its price is higher than that of other food products such as beef and chicken (Sarieva *et al.*, 2008). Historically, the Kyrgyz people have had a preference for meat over fish. However, during the USSR era there was a mandatory fish day per week, and consequently consumption was higher (i.e. in 1988–1992, annual *per capita* fish consumption was 10.50 kg), than in the post-USSR era (Alpiev *et al.*, 2013).

There is need to increase consumption of fish and fisheries products in the Kyrgyz Republic. This may be achieved by campaigns to promote the advantages of fish consumption and its positive impact on nutrition, and by consumption campaigns (for example a fish day as occurred in the USSR era). Such activities should increase demand for fish, which will ultimately increase the demand for quality feed to enhance fish production in the Kyrgyz Republic.

Improve fish production and management systems

The current fish production system in the Kyrgyz Republic is very extensive, and most farmers (particularly those farming carp) use home/farm-made feed. Farmers are typically unaware of the benefits of pelleted feed. Thus there is a need to increase farmers' awareness of the positive impact of extruded pelleted feed on fish yield. Training, demonstration farms, workshops and similar type of educational activities for improved fish production and management would likely increase demand for use of quality feed in fish production.

Improve market conditions for traders and consumers

Currently there is no well-organized market for aquafeed and feed ingredients in the Kyrgyz Republic. The existing markets typically have very poor infrastructure, and are located in private buildings.

Most of the wholesalers and retailers suggested that the Kyrgyz government can build markets with modern facilities, (such as being heated in winter), in different locations in the country, for wholesalers and retailers of aquafeed and feed ingredients. Such markets will facilitate development of this sub-sector, as both the sellers and buyer will be more comfortable in their marketing activities than at present. Furthermore, the government may receive revenue by leasing the markets to the wholesalers and retailers.

Increased availability of alternatives for expensive feed and feed ingredients

Currently finished feed and fingerlings are imported only by a few importers, and this situation represents a kind of monopoly. Government intervention is needed, such as the application of import regulations for imports, encouragement of multiple importers, establishing or supporting the local entrepreneurs to establish feed mills, and price controls, to break up or reduce, the monopoly.

Fishmeal is the most expensive part of aquafeed, particularly for rainbow trout. However, fishmeal is not available in the Kyrgyz Republic, and must be imported. Finding an alternative to fishmeal could reduce costs. Potential alternative could be algal meals, single cell protein, insect protein, animal and fish by-products, food processing by-products, earthworms, and nutrient-rich forages (Tacon, Metian and Hasan, 2009; El-Sayed, Dickson and El-Naggar, 2015). Currently some of the feed

manufacturers in the Kyrgyz Republic are trying to substitute fishmeal with insects. One such feed manufacturer/fish producer is producing aquafeed by using earthworm, fish by-products, and food processing by-products, (this company has restaurant facilities adjacent to the farm). More research and dissemination of this technological advancement are needed for large-scale production. The above initiatives may eventually facilitate the availability of alternative feed and feed ingredients in the country.

Improve capacity for production of high quality feeds

Quality control and inspection procedures need to be strong, and significant improvement is needed. Currently there are no facilities for proximate analysis of feed and feed ingredients in the Kyrgyz Republic. Very few feed manufacturers have their own feed testing equipment, and even if equipment is present, it may not be of a sufficiently high standard to allow precise measurement. Feed mills should have their own analytical facilities so they can test ingredients, and verify that finished feeds meet the expected specifications. Regular testing of feed ingredients and finished feeds need to include proximate analysis and detection of contaminants such as mycotoxins.

Inspection of feed producers, feed suppliers and ingredient suppliers is necessary to ensure that they comply with the international quality control standards, such as Hazard Analysis and Critical Control Points (HACCP), the Code of Practice for Good Animal Feeding, and International Organization for Standardization (ISO) standards such as ISO9000 and ISO9001 (FAO, 1998). However, the government organizations in the Kyrgyz Republic with responsibility for inspecting and monitoring the quality of feed and feed ingredients, such as the Veterinary Inspection Council, Center for Standardization and Metrology, and the Department of Certification and Registration, have only limited resources and facilities, including those of finance and human capital.

Investment is needed from the Kyrgyz government and from international donors to strengthen the feed inspection facilities, for proper monitoring of feed quality. Such improvements may build consumer trust about using feed produced in the country rather than expensive imported feed, a change that will ultimately help development of the aquafeed sector in the Kyrgyz Republic.

Access to credit, extension and training, and technologies

Most of the conventional feed mills in the Kyrgyz Republic use old and poorly maintained equipment, and do not observe best practices throughout feed handling, processing and storage. Thus poor quality feed is produced, and farmers may choose not to rely on such feed.

Most of the fish farmers and entrepreneurs are poor, and therefore it is very difficult for them to provide financing from their own sources for the amount of investment needed. All the value chain actors reported that there is need for collateral-free, and timely credit, with a low interest rate, from formal sources such as banks. The financial institutions need to be familiar with the structure and function of the aquafeed value chain, and design their financial products, including loans, accordingly.

In general, the government extension departments are weak, with restricted finance and few well-trained personnel. This limitation is of particular consequence in the Kyrgyz Republic, in which aquaculture production methods are extensive and traditional, contrasting with the intensive and modern production methods used in other countries in Asia. Extension agents and personnel in government agencies should be properly trained in modern production methods and quality control mechanism, so that they can effectively monitor and advise on better feed quality, production and management.

Furthermore, there is an unmet need for training for all the actors in their respective fields of operation, to increase their capacity and knowledge base. For example, feed producers will require training on sourcing of quality materials, feed formulation, feed

processing, equipment maintenance, marketing and business management, to ensure the high quality feed production expected by their customers. Feed producers also need training in feed storage, on-farm feeding and feed management to improve the efficiency of feed use.

Many of these problems can be solved through new investment in modern feed mills, quality analysis of feed and feed ingredients, and training.

Strengthen legal, institutional and policy environments

In the Kyrgyz Republic, there is no regulation on aquafeed, and few regulations on aquaculture. There are significant weaknesses in the existing legal framework, and its application and enforcement are scarce in the aquaculture sector in general and the aquafeed sector in particular.

There is a need for registration and regular inspections in the feed production sector, and for assessing and enforcing quality standards. A key need is the availability of sufficient well-trained personnel in academic and research organizations as well as in government institutions that are directly or indirectly related to this sub-sector. The large deficiencies in the quality of academic and research organization will hinder the development of the sector.

A good policy environment is necessary to support development of the aquafeed sector. Policies could include a low import tariff for importing aquafeed ingredients, a high import tariff for importing finished feed, and a low export tariff for exporting aquafeed. Such policies can be implemented within the custom union laws, because the Kyrgyz Republic is a new member of the Custom Union.

Other than the above seven recommendations, there is need for interventions by different stakeholders (including all the value chain actors, government, non-governmental and international organizations), that may help both to safeguard the current benefits being generated in the sub-sector, and improve the efficiency and profitability of the aquafeed sub-sector. Ultimately such interventions and policy environment should support growth of the aquaculture sector, ensuring that it continues to provide nutritional benefits to consumers in the Kyrgyz Republic.

SECTION B:

Business plan and feasibility analysis of establishing a feed mill under a public–private partnership (PPP) lease agreement in the Kyrgyz Republic

1. BACKGROUND AND HISTORY

The supply of good quality, nutritionally complete, feeds is a big challenge in the Kyrgyz Republic. In 2016, there was closure of the only commercial trout feed manufacturing plant in the country (Combifood), there is no commercial feed manufacturing plant producing feeds for the carps. Consequently, most farmers undertake ad hoc feeding with available feed ingredients, or alternatively they have to rely on imported feeds, primarily sourced from Denmark and Poland.

This report presents one of the outcomes of the FAO Technical Cooperation Programme Project (TCP/KYR/3502) in the Kyrgyz Republic entitled “Enhancing aquaculture production for food security and rural development through improved feed value chain, production and use”. More specifically, this report documents the business plan for establishing a feed mill under a public-private partnership agreement between the Department of Pastures, Livestock and Fisheries (DPLF) under the Ministry of Agriculture, Food Industry and Melioration (MoAFIM) and a private partner, with the financial and technical assistance of FAO. The overall objective of this study was to develop a business plan (including a feasibility study) for private sector investment into small- and medium-scale aquafeed manufacturing in the Kyrgyz Republic, by using primary and secondary data collected from the relevant stakeholders.

2. GOALS AND OBJECTIVES OF THE STUDY

A feasibility study is an ex-ante analysis to determine the likely success or failure of a potential project, program, or business idea. If the feasibility study shows a likely success, potential investors will probably proceed with the project. On the contrary, if the feasibility study does not predict a likely success, the potential investors can save their money for a better opportunity, instead of investing in a project that is likely to fail.

The present study analyzes the potential for establishing an aquafeed mill under a lease agreement between DPLF and a private partner. The study gives information about the feasibility of establishing a feed mill by analyzing the existing physical, technical and economic factors that may affect the success or failure of its operation. The study will generate information for DPLF and for potential investors (private partners) about the potential of the proposed feed mill. In addition, the study will generate business planning information that can be used to inform a business strategy to make a successful and sustainable feed mill business, under a public and private cooperation/agreement (PPP, public-private partnership).

3. DESCRIPTION OF PRODUCTS AND SERVICES

The DPLF-private partner feed mill is expected to produce good quality trout and carp feed, commodities that are not currently available in the Kyrgyz Republic. The manufactured feed, consisting of extruded floating and sinking pellets, will typically be packed in 25 kg bags for ease of transportation; other bag sizes can also be used according to the customers' preference. The label on the bag will include the name of the feed ingredients, the proximate composition, and standard certification logo from the relevant Kyrgyz authority. Along with feed, the mill will also provide several other services to the customers, including farm delivery and retail outlets in different locations, including one outlet in the mill premises. The management of feed mill will also arrange training and extension services for the fish farmers, focusing on the importance, efficient use, quality of feed, on-farm feeding and feed management, so that farmers can build their capacity and acquire the knowledge necessary for successful aquaculture.

4. PUBLIC-PRIVATE PARTNERSHIP (PPP) FEED MILL PROFILE

The feed mill will be under the management of public-private partnership (PPP). It will remain the property of the Kyrgyz government and will be operated by the private partner.

The feed mill will be a public-private partnership enterprise, and will be registered under the Kyrgyz Republic laws and regulations. Therefore, the feed mill will be legally bound by relevant Kyrgyz Republic government rules and regulations, including those related to the environment, quality control, entrepreneurship, and business.

The FAO through its TCP Project (TCP/KYR/3502) will provide the feed mill plant under the DPLF and private partner ownership agreement. Accordingly, FAO will facilitate all the processes related to transfer of the feed mill plant to the private partner, in such a way that both parties (DPLF and the private partner) get mutual benefits, and that the feed mill runs properly in a sustainable manner, that will ultimately help to grow the aquaculture sector in the Kyrgyz Republic. The feed mill will be set up in an interested private partner's existing or rented premises. The mill premises should have all necessary facilities, including easy access to road and transport, and access to electricity and water supply. Well-trained personnel will be necessary to successfully run the feed mill, including technical, operational and business-oriented staff.

5. MARKET ASSESSMENT

Aquaculture in Central Asia remains largely an underdeveloped sector, despite significant investments during the USSR era. During 2010, aquaculture production in the Kyrgyz Republic was just 352 tonnes, about 30 percent of the total fish production of 1988-89. In 2016, this production increased to 1 931 tonnes (Section A, Table 1) (FAO, 2018). The dominant fish species in aquaculture in the Kyrgyz Republic are carps and rainbow trout although some sturgeon species (Siberian sturgeon and Russian sturgeon) are being cultured in recent years.

Production of both fish feed and seed declined in the country after the collapse of the USSR. State support for aquafeed production was withdrawn, and private entrepreneurs switched to other businesses, as the government started to privatize the state-owned farms. Furthermore, there was a general decline of state institutions and governance structures.

Between 1985 and 1990, 550 – 1 100 tonnes of fish were produced annually, by using 5 000 – 7 000 tonnes of aquafeed (Nandeesh, 2008). These data reflects the poor conversion efficiency of the feed produced and used. However, systematic and updated information on feed conversion efficiency is generally lacking in the Kyrgyz Republic.

After 2009, the situation changed, and the contribution of aquaculture to total fish production has been increasing though various technical supports provided by national

(e.g. DPLF) and international organizations (e.g. FAO). Aquaculture production is conducted primarily in private ponds and only occasionally in public ponds. The aquaculture sector is therefore, mainly dominated by private sector ponds producing 100 percent of total cultured fish in 2012 (FAO, 2014; Sarieva *et al.*, 2008).

From Table 1 (Section A) it is evident that the contribution of aquaculture to total fish production fluctuated over the years: it was lowest in 2003 (16 percent of total fish production) and thereafter started to increase, reaching 97.2 percent in 2015, which was the highest contribution after the USSR period. Similarly, capture fisheries production also fluctuated over the years, and after USSR era it was highest in 2014, with production of 227 tonnes (Section A, Table 1) (FAO, 2018).

The current and projected fish production and the projected demand for feed, based on three different feed conversion ratios (FCRs), are shown in Table 12. It is therefore projected that the Kyrgyz Republic may require 3 to 12 thousand tonnes of aquafeed depending on three different FCRs if fish production is doubled from the existing production.

TABLE 12

Current and future feed requirement of the aquaculture sector in the Kyrgyz Republic according to different rates of increase in production and feed conversion ratios (FCR)

Time	Aquaculture production (tonnes)	Feed requirement (tonnes)		
		FCR 1.5	FCR 2.0	FCR 3.0
Current (2016)	1 931	2 897	3 862	5 793
Increase in production (%)				
5	2 028	3 041	4 055	6 083
10	2 124	3 186	4 248	6 372
20	2 317	3476	4 634	6 952
50	2 897	4 345	5 793	8 690
100	3 862	5 793	7 724	11 586

Source: Aquaculture production is from FAO (2018), current and projected feed requirements have been calculated based on probable FCRs (feed conversion ratios).

The Kyrgyz Republic lacks well-documented aquaculture statistics, as it is a country in transition; therefore feed demand had to be estimated. The production area data was only available for carps with no specific information on trout production area. Therefore it was not possible to calculate feed requirements for each of these two species separately. Even though trout culture is carried out to some extent in Tup district in Issyk-Kul region, only 0.8 percent of ponds were reported to be used for trout.

Therefore, for the purpose of analysis in Table 13, it is assumed that all the ponds will be used for carp polyculture (common, grass and silver carps). Analysis of feed requirements was carried out according to administrative divisions, and provides an indication of the requirement for carp feed only.

Annual *per capita* fish consumption in the Kyrgyz Republic is very low, 2.31 kg, compared to a global average of 18.98 kg in 2013 (FAO, 2018). Even with this low consumption, the Kyrgyz Republic is currently facing a deficit of more than 14 thousand tonnes of fish, and this excess of demand over domestic supply is being met by imports from Kazakhstan and the Russian Federation. If domestic fish production could meet the current deficit, there is a need for an additional 21 to 42 thousand tonnes of aquafeed per annum, depending on three different feed conversion ratios (Table 14).

If fish consumption grows to 5 or 10 kg per capita, the demand for fish and feed will also increase (Table 14). The demand situation indicates that there is a good potential market for aquafeed in the Kyrgyz Republic. Thus, the feed manufacturers can be confident that their feed mills will be profitable and sustainable.

TABLE 13
Estimated total feed requirement for carp, based on the surface area of the ponds in six different administrative divisions* in the Kyrgyz Republic

Administrative divisions	Number of fish farms	Number of ponds	Surface area of fish farms (ha)**	Surface area of ponds (ha)	Estimated feed requirement (tonnes/year)***
Chuy	93	188	1 354	1 163	12 095
Issyk-Kul	112	186	868	696	7 239
Jalal-Abad	13	31	12	6	62
Naryn	22	37	30	8	83
Osh	7	117	274	253	2 631
Talas	20	67	408	375	3 900
Total	267	626	2 946	2 501	26 010

Notes: *Information of the pond area was not accessible for Batken division; **the surface area of the fish farm comprises the surface area of the pond, plus the surface area of the non-pond; ***the annual feed requirement is calculated by multiplying the surface area of the ponds by 10.4 tonnes (per hectare feed requirement data provided by the 'Koldun Toru' Fisheries Association). Usually the duration of production cycle of carps in the Kyrgyz Republic is seven months in one year.

Source: 2016 field survey.

TABLE 14
Projected feed demand based on projected increases in fish consumption, and according to three different food conversion ratios (FCR) in the Kyrgyz Republic

Per capita fish consumption (kg/year)	Required fish production (tonnes)	Projected feed requirement (tonnes)		
		FCR 1.5	FCR 2.0	FCR 3.0
Consumption in 2013				
2.3	14 030	21 045	28 060	42 090
Projected increase				
5.0	30 500	45 750	61 000	91 500
10.0	61 000	91 500	122 000	183 000

Notes: 2017 population of the Kyrgyz current population of Kyrgyzstan is 6.1 million (UN, 2017).

Source: Per capita consumption data taken from FAO (2018).

A number of ingredients and additives are required for feed production (Section A, Table 2). Many of them are locally produced in the Kyrgyz Republic and others are imported from various countries. Locally produced ingredients are mainly grains (e.g. barley, wheat, maize and oat) and other plant materials such as clover, sunflower oilcake, and sunflower oil. In contrast, animal protein source ingredients (such as fishmeal, and meat and bone meal), plant materials (such as soybean meal) and feed additives (such as vitamin, mineral mix) are imported.

Potential feed ingredients produced in the Kyrgyz Republic, with their present usage, are listed in Table 15 (please also refer to Section A, Table 2). Thus, future feed manufacturers can use a substantial amount of locally produced ingredients for quality aquafeed production in the Kyrgyz Republic, and helping to grow the backward linkages (Figure 1).

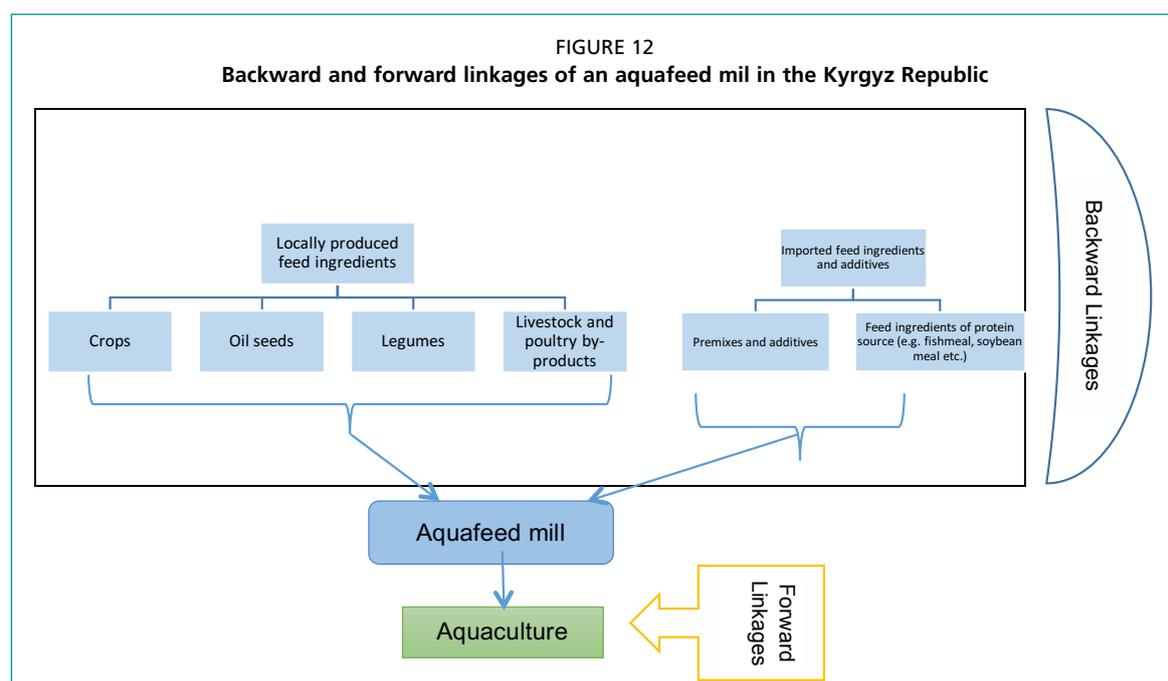
The commercial feed mill will be a major industry that will help to develop the backward linkages. The feed mill will use the by-products from oilseed, legume, livestock and poultry along with whole grain and meal of corn, wheat, barley and sorghum. Moreover, the feed mill is expected to provide feed at lower cost than imported feed, as locally produced feed ingredients will be used. The cheaper feed will benefit the small-, medium- and large-aquaculture producers in the country. In that way, the aquafeed mill, as a connector can boost the backward linkages (shows in upper portion of the Figure 12) and forward linkages (lower segment of the Figure 12, i.e. aquaculture sector) in the Kyrgyz Republic (Figure 12).

TABLE 15
Production and use of 21 feed ingredients in the Kyrgyz Republic

Ingredients produced	Use		
	Aquaculture	Livestock	Other, including human
Plants and cereals			
Barley	+	+	+
Buckwheat	+	-	+
Cereal and cereal meals	+	+	+
Maize	+	+	+
Oats	+	+	+
Rice	+	-	+
Sorghum	+	+	+
Wheat	+	+	+
Other cereals	+	+	+
Leguminous plants	+	-	+
Plant lucerne	+	+	-
Oil seeds and cakes			
Cotton	+	-	+
Oil cakes	+	+	-
Soybean	+	+	+
Sunflower	+	+	-
Grasses			
Annual grasses*	+	+	-
Panic grass	-	+	+
Perennial grasses*	+	+	-
Others			
Clover	-	+	-
Processing wastes*	+	+	-
Yeast*	+	-	+

Notes: *Ingredient not presently used, yet has potential to be used as fish feed.

Source: FAO (2011a).



6. COMPETITION ASSESSMENT

The aquafeed market in the Kyrgyz Republic is not competitive. The feed mill (Combifood) that produced trout feed shut down in 2016 (Box 1), and there are no feed mills producing feed for carp. Therefore the unit price of fish feed is high in the market, and most of the feed is imported from abroad. Imported feed is mainly for trout culture, and is imported from Poland, Denmark, the Netherlands, Russian Federation, Finland, United States of America and Turkey (Table 16). Most of the carp farmers, and some of the trout farmers, use farm-made feed, composed of ingredients available at their farm and in the local market.

BOX 1

Closure of feed mill in the Kyrgyz Republic

Historically, the Combifood Aquafeed manufacturing plant, Bishkek, produced trout starter and grower feeds for the local trout industry based in Bishkek, Tokmok, Talas and Naryn. The production plant was based on Taiwanese technology and had an installed capacity of 750 kg/hour of extruded floating feeds. In 2014, the plant produced approximately 100 tonnes of trout feed. In 2016, the plant ceased operations. The reasons for the closure were reported to be related to product quality issues, and specifically, the high moisture content in some of the manufactured feeds resulting in premature feed spoilage, and a subsequent loss of market share. In addition, the feed formulations used by the company did not include the carotenoid pigment astaxanthin. In the absence of the carotenoid, the resultant colour of the trout flesh was white as opposed to pink, resulting in some farmers electing not to use the feed as consumers' preferences were generally for a pink product.

Source: Thomas A. Shipton, personal communication, 2018.

TABLE 16
Country of origin, quantity and costs of import of feed into the Kyrgyz Republic during 2010

Feed or feed ingredient	Country from which the feed is imported	Quantity (tonnes)	Cost/tonne (USD)
Starter feed (fry/fingerling)	Denmark, Netherlands, Poland	30	2 200
Grower feed	Denmark, Finland, Poland, Russian Federation, Turkey	170	2 000
Soybean	Russian Federation, United States of America	–	315

Source: FAO (2011a).

Thus, there would be virtually no local competitors for the new feed mill in the Kyrgyz Republic, and most of the competition will be with the import market and farm-made feed. The feed produced by the new feed mill will be a substitute for imported feed, and therefore the new feed mill has to compete with the importer in terms of price and quality of feeds. It is expected that the new feed mill may eventually save some foreign currency, which currently has to be spent on feed imports.

7. MARKETING STRATEGIES

Customers/carp and trout farmers at both ends of the supply chain (Figure 12) will benefit from the feeds and services, both of which will be guided and supervised by DPLF and FAO. Other potential customers who will benefit from the locally produced feed include breeding centres, and hatcheries and nurseries (private and

public). Potential customers are located in different oblasts throughout the Kyrgyz Republic. As there is a market demand for quality feed at a reasonable price, there is a good potential for this feed mill to become a profitable business.

The field survey revealed that some farmers want to buy feed on credit, which they can repay after selling their fish, or earlier if they can do so. To address these needs, this feed mill may offer both cash and credit options for the convenience of customers.

The main marketing strategy is to increase sales, and earn profits, as the business runs sustainably, by providing quality and affordable feeds to the customers, according to their needs. To achieve this objective, the feed mill will use a number of strategies including competitive pricing, sales mechanisms, and promotional activities such as advertising.

Competitive pricing of the good quality feed will be achieved by using mostly locally produced feed ingredients, supplemented by imported feed ingredients and additives. The pricing strategy will be to sell at a lower price than the imported feed. The sales strategy will be to sell the feed through existing sales networks, through new outlets in different oblasts, and at the feed mill itself. As the feed mill will be located in an easily accessible location, the farmers can buy feed directly from the factory, without paying additional costs to intermediaries. In addition, the feed mill management will contact fish farmer cooperatives or associations in the different oblasts, and make a convenient arrangement to supply the desired amount and quality of feed at the desired price.

As most of the fish farmers, particularly those farming carp, do not use commercial pellet feeds, their yield is very low. To address this situation, the feed mill management will arrange for training and workshops for the farmers, to make them aware of the benefits of commercial feed for increasing productivity, and for efficient feed management. These outreach events will be conducted near the feed mill premises.

To build trust among the farmers about the quality of the feed, the farmers can visit the feed mill to see how the feed is prepared. Furthermore, appropriate procedures will be followed for complying with standards (such as feed quality standards e.g. 'Kyrgyz Standard') and obtaining certification (such as that for permission for feed production, distribution).

The main strategy is to sell large amount of feed at minimal profit per unit sold rather than selling small amount with high profit per unit; the former strategy should ultimately increase the overall profitability of the business. A low price strategy will ensure rapid growth in the market, yet will provide a very healthy profit, given that the feed mill will not have any direct local competition. It is most likely that the above strategy can be implemented; this feed mill will mostly use locally produced feed ingredients, and other production costs (such as labor, electricity) and marketing costs such as transportation are low compared to that in the countries supplying imported feed.

Feed mill management will include a marketing or sales department, led by a business graduate who will have experience to penetrate a new product in the market. The business strategy will be for a relationship-oriented business. To familiarize the farmers with the feed, the feed mill management will promote the feed mill from the beginning of the mill installation. Fish farmer associations will frequently be informed of the progress, so they can purchase feed from the start of production.

For publicity purposes, at the beginning of feed production in the first year, there will be new releases to all major electronic and print media in the Kyrgyz Republic. There will also be an opening ceremony where people will be invited from different stakeholders group such as DPLF, FAO and representatives from fish farmers associations, hatchery associations, and public fish farms. After the start of production, there will be regular advertisements in the electronic and print media about the feed, including its various features. There will also be a website containing information about the products and services offered by the feed mill, along with contact details.

The feed mill activities will include the following six initiatives:

- i) Arrange training for feed mill personnel in business development, management, feed management capacity and the management and inventory of raw materials.
- ii) Develop training programs for producers to promote production and management skills.
- iii) Provide technical assistance for efficient feed management and identification of product quality standards and their monitoring in the marketplaces, in collaboration with public, private, and international institutions and NGOs.
- iv) Develop and disseminate information related to the availability of aquafeed, feed quality, price and feeding techniques. The communications goal is to reach a large audience of producers through feed demonstration in major aquaculture producing areas in the country.
- v) Promote and strengthen partnerships with other feed producers, including livestock feed producers, and with government, non-government and international organizations like FAO, and with local financial and research institutions. These types of partnerships can provide support for the development and implementation of business plans, and facilitate public-private dialogues about the regulatory and policy issues that may affect the feed mill's operations.
- vi) Strengthen existing, and facilitate creation of new, aquaculture producer associations such as the Trout Growers Association, Carp Growers Association, and Hatchery Associations. These associations will be part of the feed mill network and will also serve as advocates for aquafeed producers. These types of linkages are critical for the feed mill's success.

8. FINANCIAL ANALYSIS

8.1 Start-up investments

To start up the feed mill, there are number of cost items which are shown in Table 17. The feed mill processing plant will be provided by FAO under the Technical Cooperation Programme (TCP) Project (TCP/KYR/3502), and it is assumed that feed mill will be installed within an existing building with necessary facilities for running the feed mill. Thus, most of the start-up costs will be related to renovating the existing facilities.

All the information related to cost and returns used in this section, and related tables, is based on the field survey with the potential investors, and the existing market price in the Kyrgyz Republic⁶. The total cost for establishing the feed mill under public and private partnership is estimated at USD195 095 (Table 17). The complete plant and machinery will be purchased from a reputable company in China, which will also install the machinery. Plant capacity will be 500 kg of feed/hour. The cost of plant and machinery transportation, and installation, will be provided by the supplier at USD130 000. The cost of the building including storage renovation is estimated to be USD195 58. The rental cost of land including site development is included in the financial analysis, with the assumption that a total of two hectares of land will be needed. The cost of land and site development is estimated to be USD 3 500. The cost for repairing the existing electricity line is estimated to be USD10 243, and the cost for renovating the water line and repairing and purchasing new pumps is estimated to be USD5 932. Initially there are also other costs involved, such as purchasing a weighing machine and vehicle, obtaining permission from the government authority, and miscellaneous costs, which are shown in the Table 17.

⁶ Field survey was done from 31st May to 12th June and from 9th to 25th November 2016.

TABLE 17
Estimated startup cost for a feed mill in the Kyrgyz Republic

Startup cost items	Cost (USD)
Facilities and utilities	
Processing plant (feed mill)	130 000
Building renovation	19 558
Repair of electricity line	10 243
Water pump and related renovation	5 932
Equipment	
Weighing machine	1 000
Vehicle	10 000
Compliance	
Compliance and regulatory costs (including permit)	500
Miscellaneous	
Office furniture and other supplies, 5% of total above (excluding feed mill)	2 362
Rent	
Area of land/year	3 500
Building with existing facilities including storage/year	12 000
TOTAL	
With FAO support	65 095
Without FAO support	195 095

Source: 2016 Field survey.

8.2 Profitability analysis for the feed mill

For investing in any project, it is necessary to know in detail, the variable costs, fixed costs, benefit cost ratio (BCR), net present value (NPV), internal rate of return (IRR), and expected profit. These data for the feed mill are shown in Table 18. To calculate the unit cost of feed ingredients, FAO standard feed ingredients inclusion rates were used, in conjunction with per unit market price in the the Kyrgyz Republic (Table 19).

It is evident that per tonne production of aquafeed requires USD905 in year 5 and that the cost of production is even higher in the beginning of feed mill operation. The positive and high profit indicators (gross margin, net profit) would therefore encourage a decision on investing in the feed mill business. Similarly, the project appraisal indicators such as BCR, NPV and IRR also show positive and higher than the benchmark values, meaning that investment in this feed mill will be profitable. For example NPV at 10 percent discount rate is USD 60 707, which indicates that investment in this feed mill business is a viable option. Similarly the IRR, a measure of efficiency, which is widely used to evaluate project feasibility, is also quite high, meaning that investment in this feed mill is a profitable option (Table 18).

8.3 Cash flow analysis

Cash flow analysis shows the costs of running business operations over the year, and the deficit or surplus balance that may guide any planned expansions or contraction of business. Cash flow analysis may provide hints to lenders or investors for evaluating the risk level of the business (FAO, 2011b).

For the feed mill in the Kyrgyz Republic, the cash flow of the business operation for five years is shown in Table 20. There is positive cash flows over the production cycle (seven months in one year). However, there is a negative cash inflow in the initial five months when there is no income from feed mill. Net cash flow (net income) is positive and quite high in each year. These data imply that sustainability of the aquafeed mill

TABLE 18
Costs, returns, profit indicators, and project appraisal indicators for a feed mill in the Kyrgyz Republic

	Year 1	Year 2	Year 3	Year 4	Year 5
VARIABLE COSTS (USD)					
Feed ingredients					
Carp (USD0.55/kg) ¹	13 750	27 500	55 000	82 500	110 000
Trout (USD0.78/kg) ¹	58 500	78 000	78 000	78 000	78 000
Labour: (technical and non-technical) and management ²	18 260	20 000	20 000	21 740	21 740
Electricity and fuel	2 000	2 200	2 500	3 000	3 000
Transport: feed and feed ingredients (7 month/year) (USD0.03/kg)	2 899	4 348	5 797	7 246	8 696
Maintenance and repairs	1 000	1 250	1 325	1 300	1 275
Insurance	0	5 000	5 000	5 000	5 000
Packaging (USD0.07/25 kg)	290	435	580	725	870
Feed analysis, quality inspection and monitoring	500	600	700	700	750
Government tax (USD14.49/tonne)	1 449	2 174	2 899	3 623	4 348
Sales promotion (USD7.25/ tonne)	725	1 087	1 449	1 812	2 174
Miscellaneous costs (USD2.90/tonne)	290	435	580	725	870
A. Total Variable cost	99 662	143 028	173 829	206 370	236 722
FIXED COSTS (USD)					
Depreciation: machinery including processing plant (straight-line method) ³	8 063	8 063	8 063	8 063	8 063
Rental value of land and buildings	15 000	15 000	15 000	15 000	15 000
Interest on operating capital (10%) ⁴	4 983	7 151	8 691	10 319	11 836
B. Total fixed costs	28 046	30 214	31 754	33 381	34 899
C. Total costs (A+B)	127 708	173 242	205 584	239 752	271 620
Per tonne production cost (C/D)	1 277	1 155	1 028	959	905
RETURNS					
Production of finished feed (tonnes)					
Carp	25	50	100	150	200
Trout	75	100	100	100	100
D. Total feed production (tonnes)	100	150	200	250	300
Feed price (USD/kg)					
Carp	1.09	1.09	1.09	1.09	1.09
Trout	1.52	1.52	1.52	1.52	1.52
Revenue from feed (USD)					
Carp	27 175	54 350	108 700	163 050	217 400
Trout	114 150	152 200	152 200	152 200	152 200
E. Total revenue (carp and trout) (USD)	141 325	206 550	260 900	315 250	369 600
Break-even production of feed (tonnes)⁵					
Carp	26.67	35.12	47.70	56.66	62.11
Trout	44.96	40.96	29.52	23.91	20.07
F. Total break-even production (tonnes)	71.63	76.07	77.22	80.56	82.18
PROFIT INDICATORS					
Gross margin (E - A)	41 663	63 522	87 071	108 880	132 878
Net profit (E - C)	13 617	33 308	55 316	75 498	97 980
PROJECT APPRAISAL INDICATORS					
Benefit cost ratio (BCR) (E/C)	1.11	1.19	1.27	1.31	1.36
Net present value (NPV) (discount rate 10%)	60 707				
Internal rate of return (IRR) (%)	19.10				

Notes: ¹Assume that production of 1 kg of feed requires 1 kg of feed ingredients. Detailed feed formulations are in Table 19. ²Assuming 6 staff: 1 manager @ USD435/month, 1 engineer @ USD290/month, 1 technician @ USD217/month, and 3 laborers @ USD145/month. ³Assuming 15 years as lifetime in depreciation calculation. ⁴Interest on operating capital (opportunity cost of capital) is calculated as total variable cost/2*10% (Bank interest rate). ⁵Break-even production = total fixed costs/(sales price per unit - variable cost per unit).

TABLE 19
Feed ingredients inclusion, price, and quantity of feed ingredients for producing one tonne of feed in the Kyrgyz Republic

Feed ingredients	Inclusion rate (%)		Price (KGS/kg)	Quantity (kg) needed for one tonne of feed	
	Carp	Trout		Carp	Trout
Wheat, maize and barley	64	32	15	640	320
Fishmeal	21	40	90	210	400
Sunflower meal/cake	5	-	20	50	-
Blood meal	5	4	20	50	40
Vitamin and premixes	5	2	155	50	20
Soybean meal	-	12	35	-	120
Soybean oil	-	5	80	-	50
Bone meal	-	5	20	-	50

Notes: "-" in the row indicates that the particular ingredient have not been included in the specified feed.

Source: 2016 Field survey and AFFRIS (www.fao.org/fishery/affris/en/).

TABLE 20
Cash flow and feed production price for each of five years (USD)

	Year 1													Year 2	Year 3	Year 4	Year 5
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total				
CASH OUTFLOW																	
Startup cost*	8 000	15 000	13 000	29 095	130 000	0	0	0	0	0	0	0	195 095	0	0	0	0
Variable cost	0	0	0	0	0	14 237	14 237	14 237	14 237	14 237	14 237	14 237	99 662	143 028	173 829	206 370	236 722
Fixed cost	0	0	0	0	0	2 143	2 143	2 143	2 143	2 143	2 143	2 143	15 000	15 000	15 000	15 000	15 000
Cash outflow	8 000	15 000	13 000	29 095	130 000	16 380	16 380	16 380	16 380	16 380	16 380	16 380	309 757	158 028	188 829	221 370	251 722
FEED PRODUCTION PRICE																	
Feed production (tonnes)	0	0	0	0	0	5	10	10	15	20	20	20	100	150	200	250	300
Carp feed price (USD/kg)	-	-	-	-	-	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
Trout feed price (USD/kg)	-	-	-	-	-	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
CASH INFLOW																	
Return from selling feed	0	0	0	0	0	4 566	13 045	13 045	17 394	26 090	26 090	26 090	126 320	206 550	260 900	315 250	369 600
CASH FLOW																	
Net cash flow	-8 000	-15 000	-13 000	-29 095	-130 000	-11 814	-3 335	-3 335	1 014	9 710	9 710	9 710	-183 437	485 22	72 071	93 880	117 878

Note: *Startup cost in May represents the cost of the processing plant (feed mill), which will be provided by FAO; '0' means that item did not incur in the particular months or year and '-' means that the items are not relevant in the particular months or year.

is very high due to very high profitability. Therefore private partners, as well as other stakeholders (such as foreign investors, public-private partnership and joint stock companies), should invest in this feed mill business, and financial institutions (such as banks) can give credit to the potential investors to make the aquafeed business profitable and sustainable in the Kyrgyz Republic.

9. SENSITIVITY ANALYSIS

The estimation of all the profit indicators (gross margin, net profit) and project evaluation indicators (BCR, NPV and IRR) are based on calculation of costs and returns, which are subject to varying degrees of uncertainty and risk. When the aquafeed mill operates, the actual costs and returns may differ significantly from the estimates. To address the possible differences between estimated and actual values, sensitivity

analysis investigates the impact of changes in key variables on the estimated costs and returns i.e. how sensitive the business profitability is to changes in different variables. In sensitivity analysis, the BCR, NPV and IRR are re-estimated with the changes in the variables. The subsequent sections show the results of sensitivity analysis for changes in three variables: market demand for feed, price of feed, and price of feed ingredients.

9.1 Impact of changes in market demand for feed

The impact of market demand for feed increasing or decreasing by 5 percent is shown in Table 21. In both cases the aquafeed business is still profitable, because the profit indicators (gross margin and net profit) and project evaluation indicators (BCR, NPV and IRR) remain positive and quite high. Thus investment in the aquafeed business will be profitable, even if market demand for feed increases or decreases by 5 percent.

9.2 Impact of change in price of feed

The impact of a 5 percent increase or decrease in the price of aquafeed is presented in Table 22. If the aquafeed price increases by 5 percent, the business will be highly profitable. However, if feed price decreases by 5 percent, the aquafeed business will not be profitable. Various surveys showed that in the Kyrgyz Republic, the aquafeed price is actually higher than that used in the present estimate. Therefore it is unlikely that the actual price will decrease below that used in the present estimate.

9.3 Impact of change in price of feed ingredients

A major share in aquafeed production cost is the feed ingredients cost. The impact of a 5 percent increase or decrease in price of these feed ingredients on the viability of the aquafeed business is presented in Table 23. If the price of feed ingredients decreases by 5 percent, the aquafeed business will be highly profitable. Even if the price of feed ingredients increases by 5 percent, investment in the aquafeed business is still profitable, as it is evident from the values for BCR, NPV and IRR.

10. SUSTAINABILITY ISSUES

10.1 Ownership protection aspects

The objective of establishing the feed mill is to contribute to growth of aquaculture in the Kyrgyz Republic by supplying quality feed at an affordable price, the current absence of which is one of the main reasons for slow growth of this sector. The feed mill will be established under a public-private partnership agreement, thus there will be sufficient protection for both parties to feel secure about their investments. Furthermore, legal provision should ensure that any disputes can be resolved.

10.2 Government support

To sustainably run the feed mill, government support is needed in many areas of the business. For example, government subsidized electricity will reduce the production cost, which will reduce the price of the feed, which will ultimately help the fish farmers. Similarly, low import tariffs on import of machinery and equipment for the feed mill, and on import of fishmeal and other feed additives as well as low tax for finished feed will greatly reduce the feed production cost. To protect the young domestic aquafeed market in the Kyrgyz Republic, the Kyrgyz government should impose high import tariffs on imported finished feed, to make it non-competitive with domestically produced aquafeed. All these subsidies, tariffs and taxes will help to sustainably grow the Kyrgyz aquafeed and aquaculture sector.

10.3 Credit availability, including working capital

access to credit with a low interest rate is key for business development. Thus the Kyrgyz government should facilitate access to credit for the feed miller, and for

TABLE 21
Impact of an increase and a decrease in demand for feed on the economic feasibility of a feed mill in the Kyrgyz Republic

	5% increase					5% decrease				
	Cost (USD)					Cost (USD)				
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year-4	Year-5
VARIABLE COSTS										
Feed ingredients										
Carps (USD0.55/kg)	14 438	28 875	57 750	86 625	11 5500	13 063	26 125	52 250	78 375	104 500
Trout (USD0.78/Kg)	61 425	81 900	81 900	81 900	81 900	55 575	74 100	74 100	74 100	74 100
Labour (technical and non-technical) and management	18 260	20 000	20 000	21 740	21 740	18260	20 000	20 000	21 740	21 740
Electricity and fuel	2 000	2 200	2 500	3 000	3 000	2 000	2 200	2 500	3 000	3 000
Transport: feed and feed ingredients for 7 month/year (USD28.99 /tonne)	3 043	4 565	6 087	7 609	9 130	2 754	4 130	5 507	6 884	8 261
Maintenance and repairs	1 000	1 250	1 325	1 300	1 275	1 000	1 250	1 325	1 300	1 275
Insurance	0	5 000	5 000	5 000	5000	0	5 000	5 000	5 000	5 000
Packaging (USD0.07/25 kg)	304	457	609	761	913	275	413	551	688	826
Feed analysis, quality inspection and monitoring	500	600	700	700	750	500	600	700	700	750
Government tax (USD14.49/tonne)	1 522	2 283	3 043	3 804	4 565	1 377	2 065	2 754	3 442	4 130
Sales promotion (USD7.25/ tonne)	761	1 141	1 522	1 902	2 283	688	1 033	1 377	1 721	2 065
Miscellaneous costs (USD2.90/ tonne)	304	457	609	761	914	276	413	551	688	826
A. Total variable costs	103 557	148 727	181 045	215 102	246 969	95 767	137 329	166 614	197 639	226 474
FIXED COSTS										
Depreciation for machinery including processing plant (straight-line method)	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063
Rental value of land and buildings	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Interest on operating capital (10%)	5 178	7 436	9 052	10 755	12 348	4 788	6 866	8 331	9 882	11 324
B. Total fixed costs	28 241	30 499	32 115	33 818	35 411	27 851	29 929	31 394	32 945	34 386
C. Total costs (A+B)	131 798	179 226	213 160	248 920	282 381	123 618	167 259	198 008	230 584	260 860
RETURNS										
Production of finished feed (tonnes)										
Carps	26.25	52.50	105.00	157.50	210.00	23.75	47.50	95.00	142.50	190.00
Trout	78.75	105.00	105.00	105.00	105.00	71.25	95.00	95.00	95.00	95.00
D. Total feed production (tonnes)	105.00	157.50	210.00	262.50	315.00	95.00	142.50	190.00	237.50	285.00
Feed price (USD/kg)										
Carps	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
Trout	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Revenue from feed (USD)										
Carps	28 534	57 068	114 135	171 203	228 270	25 816	51 633	103 265	154 898	206 530
Trout	119 858	159 810	159 810	159 810	159 810	108 443	144 590	144 590	144 590	144 590
E. Total revenue (carps and trout) (USD)	148 391	216 878	273 945	331 013	388 080	134 259	196 223	247 855	299 488	351 120
PROFIT INDICATORS										
Gross margin (E - A)	44 834	68 150	92 900	115 911	141 111	38 492	58 893	81 241	101 849	124 646
Net profit (E - C)	16 593	37 651	60 785	82 093	105 699	10 641	28 964	498 47	68 904	90 260
PROJECT APPRAISAL INDICATORS										
Benefit cost ratio (BCR) (E/C)	1.13	1.21	1.29	1.33	1.37	1.09	1.17	1.25	1.30	1.35
NPV (discount rate 10%)	81 709					39 705				
IRR (%)	22.03					16.07				

TABLE 22
Impact of an increase and a decrease in feed price on economic feasibility of a feed mill in the Kyrgyz Republic

	5% increase					5% decrease				
	Cost (USD)					Cost (USD)				
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year 4	Year 5
VARIABLE COSTS										
Feed ingredients										
Carps (USD0.55/kg)	13 750	27 500	55 000	82 500	110 000	13 750	27 500	55 000	82 500	110 000
Trout (USD0.78/kg)	58 500	78 000	78 000	78 000	78 000	58 500	78 000	78 000	78 000	78 000
Labour (technical and non-technical) and management	18 260	20 000	20 000	21 740	21 740	18 260	20 000	20 000	21 740	21 740
Electricity and fuel	20 00	2 200	2 500	3 000	3 000	2 000	2 200	2 500	3 000	3 000
Transport: feed and feed ingredients for 7 months/year (USD28.99/tonne)	2 899	4 348	5 797	7 246	8 696	2 899	4 348	5 797	7 246	8 696
Maintenance and repairs	1 000	1 250	1 325	1 300	1 275	1 000	1 250	1 325	1 300	1 275
Insurance	0	5 000	5 000	5 000	5 000	0	5 000	5 000	5 000	5 000
Packaging (USD0.07/25kg)	290	435	580	725	870	290	435	580	725	870
Feed analysis, quality inspection and monitoring	500	600	700	700	750	500	600	700	700	750
Government tax (USD14.49/tonne)	1 449	2 174	2 899	3 623	4 348	1 449	2 174	2 899	3 623	4 348
Sales promotion (USD7.25/tonne)	725	1 087	1 449	1 812	2 174	725	1 087	1 449	1 812	2 174
Miscellaneous cost (USD2.90/tonne)	290	435	580	725	870	290	435	580	725	870
A. Total variable cost	99 662	143 028	173 829	206 370	236 722	99 662	143 028	173 829	206 370	236 722
FIXED COSTS										
Depreciation for machinery, including processing plant (straight-line method)	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063
Rental value of land and buildings	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Interest on operating capital (10%)	4 983	7 151	8 691	10 319	11 836	4 983	7 151	8 691	10 319	11 836
B. Total fixed costs	28 046	30 214	31 754	33 381	34 899	28 046	30 214	31 754	33 381	34 899
C. Total cost (A+B)	127 708	173 243	205 584	239 752	271 620	127 708	173 243	205 584	239 752	271 620
RETURNS										
Production of finished feed (tonnes)										
Carps	25	50	100	150	200	25	50	100	150	200
Trout	75	100	100	100	100	75	100	100	100	100
D. Total feed production (tonnes)	100	150	200	250	300	100	150	200	250	300
Feed price (USD/kg)										
Carps	1.14	1.14	1.14	1.14	1.14	1.03	1.03	1.03	1.03	1.03
Trout	1.60	1.60	1.60	1.60	1.60	1.45	1.45	1.45	1.45	1.45
Revenue from feed (USD)										
Carp	28 534	57 068	114 135	171 203	228 270	25 816	51 633	103 265	154 898	206 530
Trout	119 857	159 810	159 810	159 810	159 810	108 442.5	144 590	144 590	144 590	144 590
E. Total revenue (carps and trout) (USD)	148 391	216 878	273 945	331 013	388 080	134 259	196 223	247 855	299 488	351 120
PROFIT INDICATORS										
Gross margin (E – A)	48 729	73 849	100 116	124 642	151 359	34 597	53 194	74 026	93 117	114 399
Net profit (E – C)	20 683	43 635	68 361	91 261	116 460	6 551	22 980	42 271	59 736	79 500
PROJECT APPRAISAL INDICATORS										
Benefit cost ratio (BCR) (E/C)	1.16	1.25	1.33	1.38	1.43	1.05	1.13	1.21	1.25	1.29
NPV (discount rate 10%)	107 707					13 706				
IRR (%)	25.54					12.15				

TABLE 23

Impact of an increase and a decrease in feed ingredient price on economic feasibility of a feed mill in the Kyrgyz Republic

VARIABLE COSTS	5% increase					5% decrease				
	Cost (USD)					Cost (USD)				
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 1	Year 2	Year 3	Year-4	Year-5
Feed ingredients										
Carp (USD0.55/kg)*	14 438	28 875	57 750	86 625	11 5500	13 063	26 125	52 250	78 375	104 500
Trout (USD0.78/kg)*	61 425	81 900	81 900	81 900	81 900	55 575	74 100	74 100	74 100	74 100
Labour (technical and non-technical) and management	18 260	20 000	20 000	21 740	21 740	18260	20 000	20 000	21 740	21 740
Electricity and fuel	2 000	2 200	2 500	3 000	3 000	2 000	2 200	2 500	3 000	3 000
Transport: feed and feed ingredients for 7 months/year (USD28.99/tonne)	3 043.	4 565.	6 087	7 609	9 130	2 754	4 130	5 507	6 884	8 261
Maintenance and repairs	1 000	1 250	1 325	1 300	1 275	1 000	1 250	1 325	1 300	1 275
Insurance	0	5 000	5 000	5 000	5000	0	5 000	5 000	5 000	5 000
Packaging (USD0.07/25kg)	304	457	609	761	913	275	413	551	688	826
Feed analysis, quality inspection and monitoring	500	600	700	700	750	500	600	700	700	750
Government tax (USD14.49/tonne)	1 522	2 283	3 043	3 804	4 565	1 377	2 065	2 754	3 442	4 130
Sales promotion (USD7.25/tonne)	761	1 141	1 522	1 902	2 283	688	1 033	1 377	1 721	2 065
Miscellaneous costs (USD2.90/tonne)	304	457	609	761	914	276	413	551	688	826
A. Total variable cost	103 557	148 727	181 045	215 102	246 969	95 767	137 329	166 614	197 639	226 474
FIXED COSTS										
Depreciation for machinery including processing plant (straight-line method)	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063	8 063
Rental value of land and buildings	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000	15 000
Interest on operating capital (10%)	5 178	7 436	9 052	10 755	12 348	4 788	6 866	8 331	9 882	11 324
B. Total fixed cost	28 241	30 499	32 115	33 818	35 411	27 851	29 929	31 394	32 945	34 386
C. Total cost (A+B)	131 798	179 226	213 160	248 920	282 381	123 618	167 259	198 008	230 584	260 860
RETURNS										
Production of finished feed (tonnes)										
Carp	25	50	100	150	200	25	50	100	150	200
Trout	75	100	100	100	100	75	100	100	100	100
D. Total feed production (tonnes)	100	150	200	250	300	100	150	200	250	300
Feed price (USD/kg)										
Carp	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09
Trout	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52	1.52
Revenue from feed (USD)										
Carp	27 175	54 350	108 700	163 050	217 400	27 175	54 350	108 700	163 050	217 400
Trout	114 150	152 200	152 200	152 200	152 200	114 150	152 200	152 200	152 200	152 200
E. Total revenue (carp and trout) (USD)	141 325	206 550	260 900	315 250	369 600	141 325	206 550	260 900	315 250	369 600
PROFIT INDICATORS										
Gross margin (E – A)	38 050	58 247	80 421	100 855	123 479	45 275	68 797	93 721	116 905	142 279
Net profit (E – C)	9 824	27 769	48 334	67 072	88 110	17 410	38 846	62 299	83 924	107 850
PROJECT APPRAISAL INDICATORS										
Benefit cost ratio (BCR) (E/C)	1.07	1.16	1.23	1.27	1.31	1.14	1.23	1.31	1.36	1.41
NPV (discount rate 10%)	36 749					84 665				
IRR (%)	15.63					22.44				

* In case of 5% increase/decrease in feed ingredient price, the carp feed ingredient price increases/decreases by USD0.03/kg (USD0.55±0.03/kg) while the trout feed ingredient price increases/decreases by USD0.04/kg (USD0.78±0.04/kg).

aquaculture farmers and other value chain actors. The credit should be available and accessible in a short time frame, with a low interest rate and a long payback period, to enable the businesses to run sustainably. Such easy access to credit will also help new entrepreneurs to enter the aquaculture business.

10.4 Investment protection mechanisms

Business in general is risky, as it involves significant financial investment. Thus it is necessary to have risk mitigation measures such as insurance in place. However in developing countries like the Kyrgyz Republic, such risk mitigation measures are rare.

The government should ensure provision of insurance mechanisms, and that entrepreneurs such as feed mill owners have insurance for their business, to protect them in times of crises or accidents. Feed millers should have their own risk management measures, such as diversified feed production for different species. The new feed mill will have both options, as FAO will bear the insurance for the first year, thereafter the mill should take insurance with a reputable company, and the mill will produce diversified products, namely feed for rainbow trout as well as for carp.

10.5 Capacity building and extension support

In general, there is a lack of human capital in the Kyrgyz Republic. This situation is of particular concern for the aquaculture sector, in which there is scarcity of efficient and specialized labour. For example, currently there are very few feed experts in the Kyrgyz Republic who can understand and analyze feed quality. Although there were many specialists working in and supporting the aquaculture sector during USSR era, after the Kyrgyz Republic became independent, many individuals changed their profession or migrated to other countries.

In addition, the extension system for aquaculture is very weak. Thus investment in capacity building is needed from government, donors and international organizations. Activities for building capacity and strengthening the extension system will help to grow the aquaculture sector, increasing the demand for aquafeed, which will ultimately help to sustainably run the feed mill.

10.6 Food safety and quality issues

The field survey with aquaculture farmers revealed that most of them consider the locally produced commercial feed available in the market to be of poor quality. Thus, a particular challenge for the new feed mill will be to gain the trust of the customers, so that they can trust the quality of the feed.

Food safety is currently not well developed in the Kyrgyz Republic; rules and regulations on quality and food safety are few, and outdated. To address this situation, the feed mill will check the feed quality regularly, by analyzing both the feed ingredients and the finished feed through working with a feed expert⁷ who has sufficient knowledge on proximate composition analysis of feed and other aspects of feed quality. Furthermore, to produce good quality feed, the feed mill will follow all the available legislation and standards of the Kyrgyz Republic (if applicable), as well as the customs union, rules and regulations and international feed standards. All the quality and certification information will be labeled on the feedbag, so that customers can be informed before making a purchase decision.

11. CONCLUSION

The key priority for a successful feed mill is to meet the demand for a consistently high quality feed in the market. Such high quality aquafeeds are relatively new for the emerging aquaculture sector of the country. There are some challenges because there

⁷ Researcher/scientist working in a university or research institution.

are currently no feed standards applied or enforced as such feed standards are outdated and not up to the international standard in the Kyrgyz Republic. In absence of national feed standards, the feed mill should follow standards that are available in neighboring countries or those that are internationally accepted. Developing a commercially viable aquafeed sub-sector requires increased demand for trout and carp feed from aquaculture producers. The business plan, including profit and project evaluation indicators, shows that investment in the aquafeed business will be a profitable option for the private partner, with financial institutions such as banks providing credit for the sustainable operation of the business.

References

- ADB. 2017. *Poverty in the Kyrgyz Republic*. Country profile. (available at www.adb.org/countries/kyrgyz-republic/poverty).
- AFFRIS. 2017. *Aquaculture Feed and Fertilizer Resources Information System*. Rome, FAO. (available at www.fao.org/fishery/affris/en/).
- Ahmed, N. 2007. Economics of aquaculture feeding practices: Bangladesh. In M.R. Hasan, ed. *Economics of aquaculture feeding practices in selected Asian countries*, pp. 33–64. FAO Fisheries Technical Paper No. 505. Rome, FAO. 205 pp.
- Ahmed, N., Alam, M.F. & Hasan, M.R. 2010. The economics of sutchi catfish (*Pangasianodon hypophthalmus*) aquaculture under three different farming systems in rural Bangladesh. *Aquaculture Research*, 41(11): 1668–1682.
- Alpiev, M., Sarieva, M., Siriwardena, S.N., Valbo-Jørgensen, J. & Woynárovich, A. 2013. *Fish species introductions in the Kyrgyz Republic*. FAO Fisheries and Aquaculture Technical Paper No. 584. Rome, FAO. 108 pp.
- Armstrong, G. & Kotler, P. 2011. *Marketing: An Introduction, Global Edition*. New Jersey, Prentice Hall. 640 pp.
- Christensen, V., Steenbeek, J., & Failler, P. 2011. A combined ecosystem and value chain modeling approach for evaluating societal cost and benefit of fishing. *Ecological Modelling*, 222(3): 857–864.
- Corner, R.A. 2011. *Environmental impact assessment policy and process for aquaculture in the Kyrgyz Republic*. Report of the FAO Project Support to Fishery and Aquaculture Management in the Kyrgyz Republic GCP/KYR/003/FIN. 93 pp. (available at www.researchgate.net/publication/236217514_Environmental_Impact_Assessment_Policy_and_Process_for_Aquaculture_in_the_Kyrgyz_Republic_FAO_Project_Support_to_Fishery_and_Aquaculture_Management_in_the_Kyrgyz_Republic_GCPKYR003FIN).
- Dillon, J.I. & Hardaker, J.B. 1980. *Farm management research for small farmer development*. Farm Agriculture Service Bulletin 41. Rome, FAO. 145 pp.
- El-Sayed, A.F. M., Dickson, M. W. & El-Naggar, G. O. 2015. Value chain analysis of the aquaculture feed sector in Egypt. *Aquaculture*, 437: 92–101.
- FAO, 1998. *Animal feed and food safety*. Food and Nutrition Paper No. 69. Rome. 48 pp.
- FAO. 2006. *Strengthening national food control systems: Guidelines to assess capacity building needs*. Rome. 136 pp.
- FAO. 2011a. *Aquaculture productivity enhancement opportunities in three central Asian countries (Uzbekistan, Tajikistan and Kyrgyzstan) by developing better management practices with focus on improving feed quality and availability*. Unpublished FAO Report. Rome and Ankara. 98 pp.
- FAO. 2011b. *Manual for business planning and economic feasibility of aquaculture and fisheries*. Unpublished manual. Rome and Ankara. 39 pp.
- FAO. 2014. *Fishery and aquaculture country profiles: Kyrgyzstan*. (available at www.fao.org/fishery/facp/KGZ/en).
- FAO. 2018. FishStatJ version 3.04.6. Rome. (available at www.fao.org/fishery/statistics/software/fishstatj/en).
- Gammage, S. 2009. *Gender and pro-poor value chain analysis: Insights from the Gate Project methodology and case studies*. Prepared under the Greater Access to Trade Expansion (GATE) Project under the Women in Development IQC. Washington, D.C., USAID. (available at <https://pdfs.semanticscholar.org/0dc6/aa3aaf2196616c94eb6a722b456afd4bb103.pdf>).

- Gereffi, G., Humphrey, J., & Sturgeon, T. 2005. The governance of global value chains. *Review of International Political Economy*, 12(1): 78–104.
- Ilibezova, E., Sharafutdinova, M., Kerimbekov, A., Invei, Y., Tenizbaeva, J., Ilibezova, L. & Siriwardena, S.N. 2013. *Fish marketing and consumption survey in the Kyrgyz Republic*. FAO Fisheries and Aquaculture Circular No. 1087. Rome, FAO. 65 pp. (available at www.fao.org/3/a-i3505e.pdf).
- Islam, A.H.M.S. 2016. Integrated rice-fish farming system in Bangladesh: An ex-ante value chain evaluation framework. In F.W. Gatzweiler & J. von Braun, eds. *Technological and Institutional Innovations for Marginalized Smallholders in Agricultural Development*, pp. 289–322. Springer. International Publishing. 435 pp. (available at www.springer.com/gp/book/9783319257167).
- Kalnins, S.N. & Joldubaeva, L. 2008. *Strengthening policy and regulatory framework for mainstreaming biodiversity into fishery sector*. Final Evaluation Report. UNDP-GEF Medium-Size Project (MSP) document. State Agency on Environment and Forestry under the Government of Kyrgyz Republic. United Nations Development Programme, Kyrgyzstan. 89 pp.
- Kaplinsky, R., and M. Morris. 2001. *A Handbook for Value Chain Research*. Ottawa, IDRC. 109 pp. (available at www.ids.ac.uk/ids/global/pdfs/ValuechainHBRKMMNov2001.pdf).
- Kohls, R.L. & Uhl, J.N. 1985. *The marketing of agricultural products*. New Jersey, Prentice Hall. 544 pp.
- Kustareva, L.A., & Naseka, A. M. 2015. Fish diversity in Kyrgyzstan: species composition, fisheries and management problems. *Aquatic Ecosystem Health & Management*, 18(2): 149–159.
- Macfadyen, G., Nasr-Alla, A.M., Al-Kenawy, D., Fathi, M., Hebicha, H., Diab, A.M., Hussein, S.M., Abou-Zeid, R.M. & El-Naggar, G. 2012. Value-chain analysis-An assessment methodology to estimate Egyptian aquaculture sector performance. *Aquaculture*, 362: 18–27.
- Mamun-Ur-Rashid, M., Belton, B., Phillips, M. & Rosentrater, K.A. 2013. Improving aquaculture feed in Bangladesh: From feed ingredients to farmer profit to safe consumption. Working Paper: 2013-34. Penang, WorldFish. 11 pp. (available at <http://aquaticcommons.org/11251/1/WF-2013-34.pdf>).
- Mayoux, L. & Mackie, G. 2008. *Making the strongest links: A practical guide to mainstreaming gender analysis in value chain development*. Addis Ababa, ILO. 96 pp. (available at http://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/instructionalmaterial/wcms_106538.pdf).
- Mikkola, H. 2012. Implication of alien species introduction to loss of fish biodiversity and livelihoods on Issyk-Kul Lake in Kyrgyzstan. In G.A. Lameed, ed. *Biodiversity Enrichment in a Diverse World*. London, IntechOpen. (available at www.cdn.intechopen.com/pdfs-wm/38666.pdf).
- Mirzabaev, A., Martius, C., Livinets, S., Nichterlein, K., & Apasov, R. 2009. Kyrgyzstan's National Agricultural Research and Extension system: An assessment of information and communication needs. *Sustainable Agriculture in Central Asia and the Caucasus Report No. 5*. Tashkent, ICARDA-CAC/FAO. 80 pp. (available at www.researchgate.net/profile/Alisher_Mirzabaev/publication/235340575_Kyrgyzstans_National_Agricultural_Research_and_Extension_System_An_Assessment_of_Information_and_Communication_Needs/links/0fcfd5138b7113126a000000.pdf).
- Nandeesh, M.C. 2008. *Report of aquafeed production technology expert*. Paper presented in Regional Workshop on Fish and Livestock Feed Assessment Methodologies, Tashkent, Uzbekistan. Unpublished Report of the TCP Project “Advice to central Asian governments on the feasibility of commercial fish and livestock feed production (TCP/RER/3205 (D))”. 18 pp.

- Nasr-Allah, A.M., Dickson, M.W., Al-Kenawy, D.A.R., Ahmed, M.F.M., & El-Naggar, G.O. 2014. Technical characteristics and economic performance of commercial tilapia hatcheries applying different management systems in Egypt. *Aquaculture*, 426: 222–230.
- Nix, J. 2000. *Farm management pocketbook*. 31st edition. London, Wye College. 244 pp.
- National Statistical Committee of Kyrgyz Republic. 2016. *National Statistical Committee of the Kyrgyz Republic*. (available at www.stat.kg/en/).
- Pickton, D.W., & Wright, S. 1998. What's SWOT in strategic analysis? *Strategic change*, 7(2): 101–109.
- Porter, M.E. 1985. *The Competitive Advantage: Creating and Sustaining Superior Performance*. New York, The Free Press. 30 pp.
- Rubin, D., Manfre, C., Barrett, K.N. 2009. *Promoting gender equitable opportunities in agricultural value chains: a handbook*. Publication Prepared under the Greater Access to Trade Expansion (GATE) Project, under the Women in Development IQC Contract No. GEW-I-00-02-00018-00, Task Order No. 02. Washington, DC, USAID. 11 pp.
- Sarieva, M., Alpiev, M., Van Anrooy, R., Jørgensen, J., Thorpe, A. & Mena Millar, A. 2008. *Capture fisheries and aquaculture in the Kyrgyz Republic: Current status and planning*. FAO Fisheries Circular No. 1030. Rome, FAO. 108 pp.
- Tacon, A.G.J., Metian, M. & Hasan, M.R. 2009. *Feed ingredients and fertilizers for farmed aquatic animals: Sources and composition*. FAO Fisheries and Aquaculture Technical Paper No. 540. Rome, FAO. 209 pp.
- Taylor, D.H. 2005. Value chain analysis: an approach to supply chain improvement in agri-food chains. *International Journal of Physical Distribution & Logistics Management*, 35(10): 744–761.
- Thorpe, A. & Van Anrooy, R. 2010. Strategies for the rehabilitation of the inland fisheries sector in Central Asia. *Fisheries Management and Ecology*, 17(2): 134–140.
- Thorpe, A., Van Anrooy, R., Niyazov, B.N., Sarieva, M.K., Valbo-Jørgensen, J., & Millar, A.M. 2009. The collapse of the fisheries sector in Kyrgyzstan: an analysis of its roots and its prospects for revival. *Communist and Post-Communist Studies*, 42(1): 141–163.
- Thyresson, M., Crona, B., Nyström, M., de la Torre-Castro, M., & Jiddawi, N. 2013. Tracing value chains to understand effects of trade on coral reef fish in Zanzibar, Tanzania. *Marine Policy*, 38: 246–256.
- UNIDO (United Nations Industrial Development Organization). 2009. *Agro-Value Chain Analysis and Development: The UNIDO Approach*. Vienna, UNIDO. 74 pp. (available at www.unido.org/sites/default/files/2010-02/Agro_value_chain_analysis_and_development_0.pdf).
- USAID. 2009. *Gender and Pro-poor Value Chain Analysis: Insights from the Gate Project Methodology and Case Studies*. 27 pp. (available at https://microlinks.org/sites/microlinks/files/group/resource/files/GATE_Gender_Pro-Poor_Value_Chain_Analysis_05-09.pdf).
- USDA Foreign Agricultural Service. 2015. *Kyrgyzstan Joins Eurasian Economic Union*. GAIN Report. Global Agricultural Information Network. GAIN Report Number: KG1503. (available at https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Kyrgyzstan%20Joins%20Eurasian%20Economic%20Union_Moscow_Kyrgyzstan%20-%20Republic%20of_8-19-2015.pdf).
- UN (United Nations, Department of Economic and Social Affairs, Population Division). 2017. *World Population Prospects: The 2017 Revision, DVD Edition*. (available at <https://esa.un.org/unpd/wpp/Download/Standard/Population/>).

- Velu, A., Gessese, N., Ragasa, C., & Okali, C.** 2009. *Gender analysis of aquaculture value chain in Northeast Vietnam and Nigeria*. World Bank agriculture and rural development discussion paper, 44. Agriculture & Rural Development Department, World Bank. 158 pp. (available at <http://documents.worldbank.org/curated/en/954161468155727109/Gender-analysis-of-aquaculture-value-chain-in-Northeast-Vietnam-and-Nigeria>).
- Womack, J.P. & Jones, D.T.** 2003. *Lean thinking: banish waste and create wealth for your corporation*. New York, Simon and Schuster. 397 pp.
- Yüksel, I., & Dagdeviren, M.** 2007. Using the analytic network process (ANP) in a SWOT analysis—A case study for a textile firm. *Information Sciences*, 177(16): 3364–3382.

For the Kyrgyz Republic, an aquafeed value chain analysis was conducted, and a business plan for establishing a small-scale feed mill was developed. The results are based on a review of publications, and institutional, policy, and legislative documents, and the data from surveys, observations, focus group discussion, and interviews with key individuals in the aquafeed value chain. It is evident that the Kyrgyz republic aquafeed sub-sector is still in its development stage, and has a very simple value chain. Nevertheless, the sub-sector has the potential to play an important role in aquaculture development. Feed is a crucial limiting factor for aquaculture and accounts for a major share of its total operational cost. Intensification of aquaculture in Kyrgyz republic is needed in the Kyrgyz Republic, and should be supported by using increased amounts of commercial feed. The study therefore recommends establishing a public-private partnership aquafeed mill in the Kyrgyz Republic that would be feasible, viable and profitable.

ISBN 978-92-5-130984-1 ISSN 2070-7010



9 7 8 9 2 5 1 3 0 9 8 4 1

CA1586EN/1/12.18