AQUAFEED PROCESSING LABORATORIES

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❶ Extrusion Inc.
❷ Texas A&M
❸ Fôrtek
❹ INRA
❺ Kansas State University
❻ Nofima
❼ Northern Crops Institute
❽ Oceanic Institute
❾ USDA-ARS
❿ Zeigler

AQUAFEED LAB SERVICES

At a glance

	Extrusion Inc.	Food Protein R&D Center, Texas A&M University	Fôrtek Norwegian University of Life Sciences Centre for Feed Technology	INRA	Kansas State University Extrusion Lab	
Lab scale processing (= kg/hour)	✓	✓	✓	✓	✓	Lab scale processing (= kg/ hour)
Pilot scale processing (= t/ hour)	■	✓	✓	✓	✓	Pilot scale processing (= t/ hour)
Pellet physical quality assessment	■	✓	✓	■	✓	Pellet physical quality assessment
Ingredient analysis	■	■	✓	✓	■	Ingredient analysis
Formulation redesign / evaluation	✓	✓	✓	■	✓	Formula-tion redes-ign / evaluation
Feed processing protocols	✓	✓	■	■	✓	Feed processing protocols
Mill QC evaluation	■	■	■	■	■	Mill QC evaluation
Mill design	✓	■	■	■	✓	Mill design
Feed production training	✓	✓	✓	■	✓	Feed production training
Feeding trials	■	✓	✓	✓	■	Feeding trials
Final product evaluation (taste) testing	■	■	■	■	■	Final prod-uct evalua-tion (taste) testing

AQUAFEED LAB SERVICES

At a glance

	Nofima	Northern Crops Institute - North Dakota State University	Oceanic Institute	USDA Agricultural Research Service	Zeigler	
Lab scale processing (= kg/hour)	■	✓	✓	✓	✓	Lab scale processing (= kg/hour)
Pilot scale processing (= t/ hour)	✓	✓	✓	■	✓	Pilot scale processing (= t/ hour)
Pellet physical quality assessment	✓	✓	✓	✓	✓	Pellet physical quality assessment
Ingredient analysis	✓	■	✓	■	✓	Ingredient analysis
Formulation redesign / evaluation	✓	■	✓	✓	✓	Formulation redesign / evaluation
Feed processing protocols	✓	✓	✓	✓	✓	Feed processing protocols
Mill QC evaluation	■	■	■	■	✓	Mill QC evaluation
Mill design	■	✓	■	■	✓	Mill design
Feed production training	✓	✓	✓	■	✓	Feed production training
Feeding trials	✓	■	✓	✓	■	Feeding trials
Final product evaluation (taste) testing	✓	■	■	■	✓	Final product evaluation (taste) testing

Extrusion, Inc.

10 Eric Paton Way, St Johns, Auckland 1072, New Zealand.

CONTACTS:

Peter Hutchinson, Director

Stuart Walker, Director

website

RATES

All Plant hire is US$380/hr plus raw materials

“Extrusion Co Ltd (formerly EN Hutchinson Ltd) commenced extrusion operations in 1997 with the installation of a Wenger extruder and associated ancillary equipment. The plant is small scale and ideally suited for research and development of new extruded products and processes. The primary focus of the plant currently is product development projects for extruded aquaculture feed. However, the team have conducted extrusion projects ranging from biopolymers (biodegradable plastic replacers) to breakfast cereals, crumb & coating products, snack products, agricultural feeds and pet foods to name a few.

With a vision for improving feed performance, we continuously carry out development work for various international private and public sector agencies as well as producing our own unique products. Peter Hutchinson does technical work for customers in NZ, Australia, US, Asia and other locations as required, acting as a consultant for existing and development of new extrusion plants.

Extrusion Co Ltd is a fully Government Licensed export facility, operating under the NZ Food Safety Authority and Ministry for Primary Industries with a registered Risk Management Programme under strict audited HACCP [Hazard Analysis and Critical Control Point] protocols.

All feed and feed ingredient analysis available at local external laboratories. We can also arrange for feeding trials for all species at NIWA’s comprehensive fresh and salt water facility in Northland New Zealand.”

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Single Screw Extruder	200kg/hr	Wenger

Food Protein R&D Center, Texas A&M University

2476 TAMU, College Station, Texas 77843-2476, USA

CONTACT:

Mian Riaz, Head Extrusion Technology Program

website

"Food Protein R&D Center has eight extruders from lab scale to pilot plant and can make any type of feed (floating or sinking). We also have surface and vacuum coating system, as well as all types of grinding machines. We also have pulverizer and different dryers. we work with Wildlife and Fishery Department and can do feeding trails for the client."

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Pellet durability (PDI)
- Specific Density

RATES

Rates depend on the project. Charges are per day or for the entire project.

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Twin Screw Extruder	100-500 kg/hour	Wenger TX 52
Single Screw Extruder	100-500 kg/hour	Wenger X-20
Dry Extruder	200-300 kg/hour	Insta Pro 600
Dry Extruder	1000 kg/hour	Insta Pro 2000
Extruder Expander	200-500 kg/hour	Anderson 4"
Expander with Preconditioner	50-100 kg/hour	Technol
Lab Scale Expander	10-50 kg/hour	Anderson
Lab Scale Extruder	2-10 kg/hour	Brabander
Lab Scale Extruder	5-10 kg/hour	Wenger X5
Pulverizer	100-500 kg/hour	Reynolds Engineering
Pellet Mill (Lab scale)	50-100 kg/hour	CPM
Pellet Mill with Conditioner	1000 kg/hour	Bliss Pioneer
Surface coating system	500-1000 kg/hour	APEC
Vacuum coater	250 kg/hour	UAS Canada
Continuous Dryer	500-1000 kg/hour	Wenger

Centre for Feed Technology

Norwegian University of Life Sciences, Centre for Feed Technology,
Arboretveien 10, 1430 Aas, Norway.

CONTACTS:

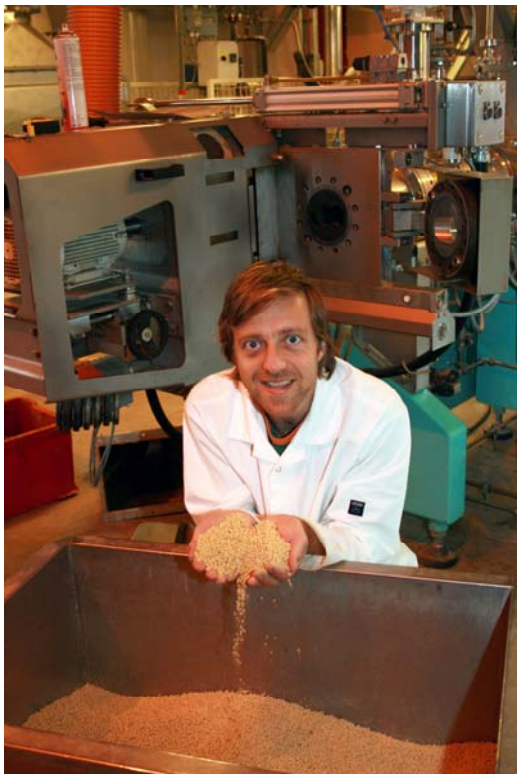
Olav Fjeld Kraugerud, Ph.D., Manager

Ismet Nikqi, Technical Manager

Dejan Miladinovic,M.Sc, Quality Manager

website

"We are focusing on processing of the feed, milling and mixing. We have experience and knowledge from both pelleting and extrusion and from pet food, fish feed, swine feed, and poultry feed. This ensures our open mindedness when dealing with new projects, resulting in added value to our clients. The Feed Tech. Centre is a small and flexible organization, and we have close connection to the other departments at the University, ensuring access to both facilities and expertise if we consider it necessary. If desired, we can then run trials covering the whole value chain from feed making to feeding trial with subsequent sampling for you as a customer."



OFKExtruder: Showing Manager, Dr. Olav Kraugerud during his Ph.D. work in 2008 in front of the BCTB 62 extruder. (Photo by Maya Fog, UMB)

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Pellet durability (PDI)
- Sinking velocity
- Particle size distribution

INGREDIENT/FEED ANALYSIS

Lab equipment/analysis:
HPLC, GC, NIR, DSC.

- Proximates
- Kjeldahl Nitrogen, Dumas Nitrogen, Amino acids
- Crude lipids, Fatty acids
- Starch
- Starch gelatinization by DSC
- Dry matter, Ash
- Minerals

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Cutting mill, 1.5 - 0.2 mm sieve	up to 10 kg/hr	Fritsch P19
Pellet press Twin Pass RMP-350.100	1200 kg/hr	Muench
Expander OE 15-1/2	1200 kg/hr	Kahl
Extruder Twin screw BCTG 62	800 kg/hr	Bühler
Hammermill E-22115 TF, 0.8 - 8.0 mm sieve	2000 kg/hr	Muench
Roller mill DT900-12	3000 kg/hr	CPM
Automated batching system	3500 kg/hr	Able USA
One section, single screw extruder. Temperature adjusted barrel (10-115 °C). This is a modified pasta machine.	15-35 kg/hr	Italgi P35
Twin shaft Mixer Tatham 1992 OB -1078 400	1200-6000 kg/hr	Forberg
Twin shaft vacuum Mixer 200L	1200 kg/hr	Dinnissen
Twin shaft mixer conditioner F-60	Batch	Forberg
Twin shaft mixer 40L	Batch	Ide-Con
Twin shaft vacuum Mixer 6L	Batch	Forberg
COMING Fall 2013: Small scale twin screw extruder	30 kg/hr	TBA

FEEDING TRIALS

Center for Feed Technology has re-circulating tank systems for digestibility feeding trials for both warm and coldwater fish.

RATES

For pure processing tasks, daily/hourly rates apply. Contract terms are negotiated for larger projects.

INRA (French National Institute for Agricultural Research)

UR 1067, Nutrition, Metabolism & Aquaculture Unit, Pôle Hydrobiologie, 64310 St-Pée-sur-Nivelle, France.

CONTACTS:

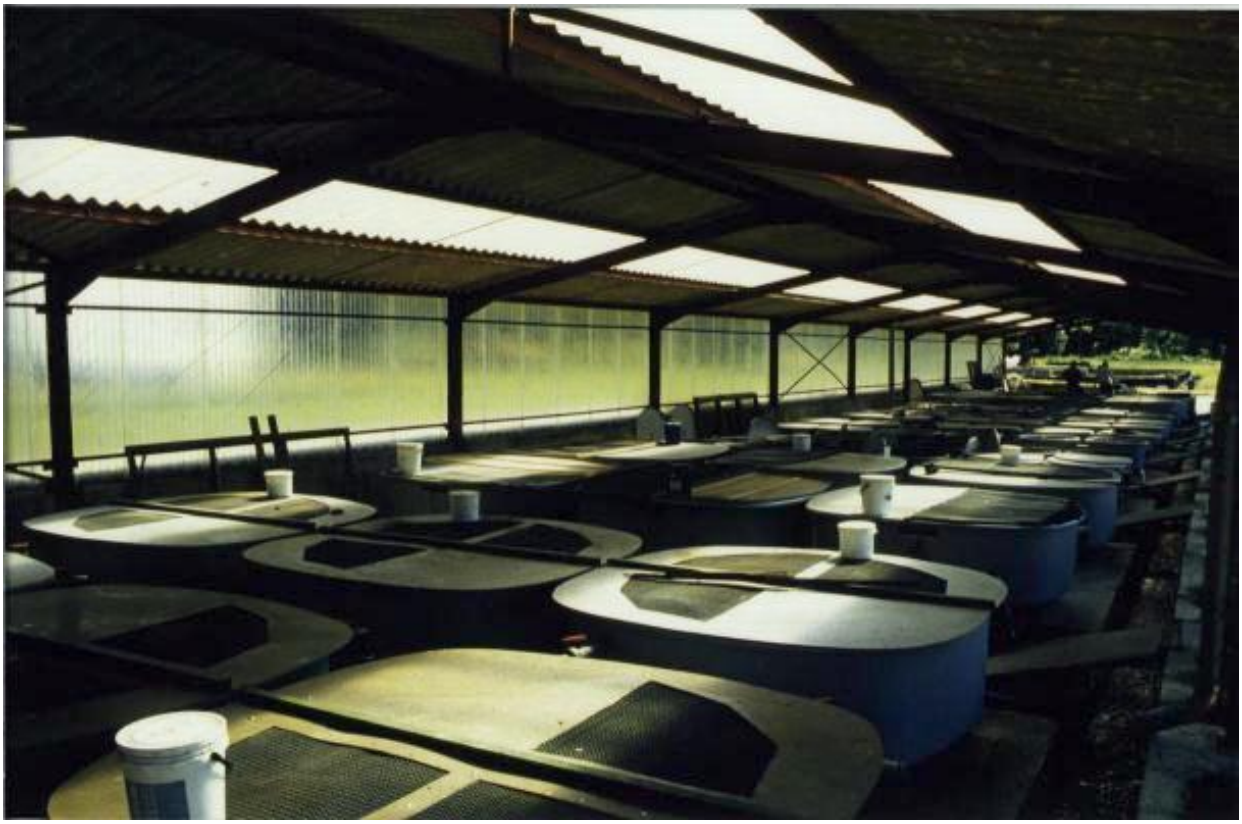
Frédéric Vallee

Christine Burel

website

“INRA St Pée Infrastructure is a unique set of installations devoted to nutrition research in freshwater salmonids. The research unit is internationally-recognized in fish nutrition and metabolism, much involved in joint research activities with partners from both private and public sectors.

The facilities include three platforms, two full scale experimental fish farms with flow through raceways supplied with water at constant water temperature (8 and 17°C) and one specialized, original dedicated facility for fish nutrition research under controlled re-circulated water systems that allows feeding behaviour studies and digestibility measurements. These facilities thus enable fish nutrition research work all through the life cycle from larvae to broodstock.



The Experimental fish farm at Donzacq has a complete feed manufacturing plant with a twin-screw extruder. There are also wet lab facilities for in vivo work as well as samplings. The water supply is from natural springs at a constant 17°C with oxygenation and gas desaturation. The farm has large (160 cubic meters) and small scale (5000 and 200L) flow through raceways and individual tanks of different sizes: 20 small tanks of 50L for hatchlings, 48 1m² tanks, 18 2m² tanks, the latter potentially attached to computer controlled eater-feeders.

At the experimental fish farm at Lees Athas, a constant water temperature of 7°C enables nutrition studies on cold water salmonids.. The facility comprises of 11 flow through raceways enabling studies on more than 400 groups of eggs until hatching; a UV-treated thermoregulated system for the production of eggs and fry; 84 self-cleaning tanks for growing juvenile salmonids, of special interest for studies on nutrient-genotype interactions, 16 tanks of 200L, 32 tanks of 500L; 6 concrete out-door circular ponds, 8 raceways of 12 to 20m3 for studies with broodstock nutrition.

Specialized facilities

Control of Feed intake and feeding rhythms: A set of 2 independent recirculated systems each with 12 tanks, each of which is equipped with an eater-meter device specially developed by the research team allows (i) monitoring activity and feeding rhythms, (ii) control feed distribution over the daily cycle and (iii) evaluation of the amount of feed distributed. Each tank being equipped with fecal collectors, accurate knowledge on feed intake by fish is gathered over long periods. Adapted with more than one feeder, the setup also enables one to discriminate feed choice by fish.

Digestibility: In a re-circulated temperature-controlled system, the system consists of 3 series of 6 cylindro-conical tanks connected with a continuous automatic fecal collector. The set up originally developed by the research unit has been recognised as the most valid method for in vivo studies on digestibility measurements with fish. This makes possible evaluation of apparent digestibility coefficients (ADC) of both diets and feed ingredients and a Quality-control system has been developed for ensuring the validity of standardised protocols and methods. In the context of nutrition related environmental impacts of aquaculture, this allows the estimation of suspended matter loss of dietary origin. ”

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Grinder	150 kg/h	N/A
Blenders (2 models)	20 kg / 400kg	N/A
Twin-screw extruder	75 kg/hr	Clextral BC45
Dryer	400 kg/D	Custom in-house fabrication
Vacuum coater	90 kg/hr	Custom in-house fabrication
Automatic sifter	50 kg/hr	N/A

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability

INGREDIENT/FEED ANALYSIS

Lab equipment / analysis:
GLC, oven furnace

- Dry matter
- Kjeldahl Nitrogen
- Fats (Folch, Soxlet)
- Fatty acids & fat soluble vitamins
- Total Ash

FEEDING TRIALS

INRA undertakes feeding trials for cold water and warm water species of freshwater fish: Digestibility, attractants, voluntary feed intake, metabolism and larval nutrition. Facilities include ponds and raceways and both flow-through and recirculation tanks. INRA is part of "Aqua-Excel", "Aquaculture Infrastructures for Excellence in European Fish Research", An EU-funded project under FP7 programme on Research Infrastructures

RATES

For feed manufacture, rates are either daily or per unit feed. Rates for trials with fish (growth, digestibility...) will vary depending on duration and analyses involved.

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Kansas State University Extrusion Lab

1980 Kimball Ave., 101 BIVAP; Suite B, Manhattan, Kansas 66535, USA.

CONTACT:

Dr Sajid Alavi, Associate Professor

Eric Maichel, Operations Manager

Max Remund, Asst. Operations Manager

website

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Pellet durability (PDI)
- Specific Density
- Particle size distribution
- Mixer testing

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Single screw extruder	300 kg/hr	Wenger X20/E325
Twin screw extruder	150 kg/hr	Wenger TX52
Dryer	400 kg/hr	Wenger 4800 Series
Cooler	400 kg/hr	Wenger 4800 Series
Coating drum/reel	400 kg/hr	Wenger
Coated product cooler	400 kg/hr	Wenger

RATES

All projects are charged on a set fee schedule approved by the State of Kansas. Please contact for current pricing and project quotes

Northern Crops Institute - North Dakota State University

NDSU-Dept. 7400, P.O. Box 6050, Fargo, ND 58108-6050, USA.

CONTACT:

Kim B Koch, Manager

John Crabtree, Assistant Director

website

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Pellet durability (PDI)
- Particle size distribution
- Mixer testing

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Pellet press	2000-3000 kg/hr	CPM Hyflo
Twin screw extruder	300-500 kg/hr	Wenger TX52
Hammer mill	6000-7000 kg/hr	Bliss
Mixer	8000 kg/hr	Scott
Pulverizer	10-200 kg/hr	Fitzpatrick

RATES

The daily fee for use of the TX-52 in the extrusion facility or the pellet press located in the feed production center is 1,500 US$. The TX-52 is in a food-grade setting and NCI reserves the right to disallow the use of nonfood-grade materials.

Nofima

Nofima AS, Kjerreidviken 16, NO-5141 Fyllingsdalen, Norway

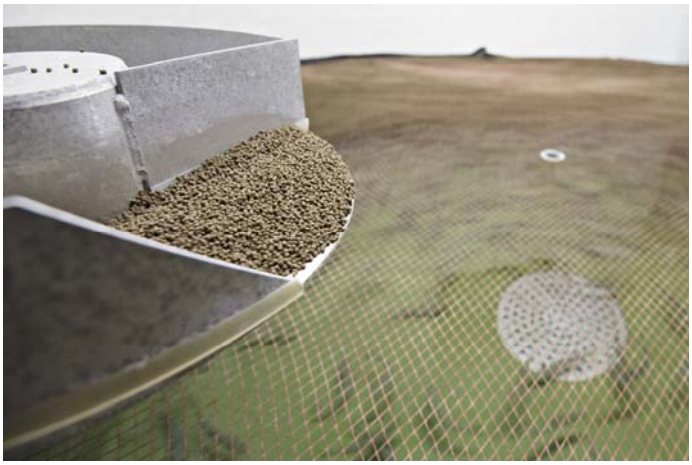
CONTACTS:

Odd Helge Romarheim, Manager/Researcher

Andrè Bogevik, Researcher

Torbjørn Åsgård, Director of Research

website



PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Specific density
- Pellet durability (PDI)
- Particle size distribution
- Oil absorption leakage
- Sinking velocity

“Nofima, the Norwegian Institute of Food, Fishery and Aquaculture, is Europe’s largest institute for applied research within the fields of fisheries, aquaculture and food. We carry out internationally recognized research and develop solutions that provide a competitive edge throughout the whole value chain from ingredient processing to edible food for human consumption.

The Feed Technology Centre belonging to Nofima has a fully equipped factory in pilot scale for production and evaluation of experimental aquaculture feed. Feed are developed to have a high nutritional and physical quality with existing and novel feed ingredients. Improvement of feed requires interdisciplinary knowledge in the fields of ingredient quality and processing, feed technology, nutrition and product quality, and Nofima possess considerable experience in all these areas. Nofima has also a central role in the development of feed for new intensively farmed fish species and larvae feed. Nofima has several aquaculture research stations for fish trials and laboratories for analytical services.”

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Twin-screw, co rotating extruder, TX 52	50-300 kg/h	Wenger
Pellet press	1-50 kg/h	Simon Heesen
Mills: hammer, retsch, roller,	1-50 kg/h	Jesma-Matador, Retsch, Apollo
Pulverizer	60 kg/h (10 micron)	Jäckering
Spray drier	25 kg/h	GEA Niro
Freeze driers	up to 6 kg ice/batch	Christ, Heto
Pellet driers: carousel, fluid-bed, tray dryer	0.5 - 300 kg/h	Paul Klöckner
Mixers	2 -1200 kg/batch	N/A
Vacuum - and top coater	200 kg/h	Dinnissen
Vacuum lab mixer and coater	2-8 kg/batch	Dinnissen
Sieves: tumbler, test-sieve shaker	2-500 kg/h	Allgaier, Endecotts
Various equipment for pellet quality tests		N/A
Phase Transition Analyzer		Wenger
Rapid Visco Analyser		Newport Scientific
Dynamic Vapour Sorption		SMS

FEEDING TRIALS

Feeding trials are undertaken for cold water species of freshwater and marine fish and crustaceans as well as sea urchin and mink. Digestibility, attractants, growth, retention, quality and health are assessed.

Facilities comprise recirculation, flow-through and zero exchange tanks and sea cages.

RATES

All research activity is project based and each project must cover costs according to a full cost model. The project is based on a signed contract and a project plan. Payment is usually in NOK and conditions depends on volume and duration of the project.

The Oceanic Institute

41-202 Kalanianaole Highway, Waimanalo, Hawai'i 96795, U.S.A

CONTACTS:

Zhi Yong Ju, Ph.D., Research Scientist

Ward Kashiwa, Research Associate

website

"We offer feed formulation development and feed manufacturing for targeted species, based on different feed processing methods used in research or industry. We also evaluate the quality of aquatic feed. We have well established analytical methods and facilities for nutrition and toxicology studies."

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Specific density
- Pellet durability (PDI)
- Particle size distribution
- Mixer testing

INGREDIENT/FEED ANALYSIS

Lab equipment/analysis:

NIR (Foss), Nitrogen (Leco), Accelerated Solvent Extractor (Dionex), Muffle furnace (Thermer), Ovens (Thermer), Bomb Calorimeters, HPLC (Agilent), GC (Varian), Texture Analyzer.

- Proximates
- Crude protein
- Crude lipids
- Ash
- Moisture
- Gross Energy
- Amino acids
- Fatty acids

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Single Screw Cooking Extruder	200 kg/hr	Wenger
Pellet Mill	5 kg/hr	CPM
Meat Grinder	1 kg/hr	Hobart
Air Swept Pulverizer	80 kg/hr	Jacobson
Hammer Mill	80 kg/hr	N/A
Cyclone sample mill	1 kg/hr	Udy
Oil Press	500 kg/hr	InstaPro
Pellet Dryer (Steam)	500 kg/hr	Wenger
Pellet Dryer (Propane)	20 kg/hr	Despatch
Post Pellet Cooker	30 kg/hr	N/A
Mixers	2,4,15,40,70 kg	Davis, Colton, Hobart, KitchenAid
Feed Crumbler	100 kg/hr	N/A
Crumble Classifying Vibratory	200 kg/hr	Sweco
Single Screw cooking extruder	150 kg/hr	InstaPro

FEEDING TRIALS

Oceanic Institute conducts growout digestibility, attractant and toxicology trials for a wide range of warmwater species: both marine and freshwater fish, crustaceans and molluscs.

Testing systems: 56 x flow-through and 56 zero-exchange tanks; 40 oval tanks (40 gal) flow or static; 60 attractant tanks, flow or static; 24 digestibility tanks, flow or static; 24 toxicology tanks, flow or static.

RATES

Fees are tailored to specific projects.

USDA/Agricultural Research Service

4050 Bridger Canyon Road, Bozeman, Montana 59715, USA

CONTACTS:

Rick Barrows, Research Physiologist / Nutritionist

website

Fish nutritionist Rick Barrows (foreground) uses a vacuum coater to infuse flax oil into pellets of rainbow trout feed containing a vitamin formula that he and colleagues developed. Technician Jason Frost removes feed pellets from a cooling table in preparation for the oil infusion, which further enriches the pellets. Photo by Stephen Ausmus.

"This program has been designed to develop alternative aquafeeds for a variety of species by focusing on ingredient evaluation and development.

The effect of alternative ingredients on feed production, feed quality and several aspects of fish performance are conducted routinely. Apparent digestibility coefficients are determined for traditional and novel ingredients (Click here for this information).

Jacketed kettles with agitators and temperature control, a variety of centrifuges, extractors, presses and dryers are using for the production of protein concentrates.

Feed and ingredient analysis is available through collaboration,"

RATES

This is not a fee for service laboratory. All projects are collaborative in nature involving topics of mutual interest, and operate on a cost-sharing basis.

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Huller-scarifier, Aspirator	150-250 kg/hr	Forsberg
Hammer mill	~75 kg/hr	Kelly Duplex
Air-swept pulverizer, 18H	100-300 kg/hr	Jacobson
Air Classifier	10-50 kg/hr	Alpine
Super-critical CO2 fluid extractor	material dependent, 4 liters	SFT
Oil Cold screw-press	40 kg/hr	Kern Kraft
Compaction Pellet Mill	30 kg/hr	CPM, Inc.
Cold micro-extruder, .5 to 1.2 mm	~ 10 kg/hr	LCI, Inc.
Spheronizer	NA	LCI, Inc.
Double drum dryer - flaker	~20 kg/hr	Buflovac, LLC
Piston cold extruder	~15 kg/hr	API
Cold Extruder, 1.5 to 3.5 mm	10-30 kg/hr	Italgi Inc.
Twin-screw cooking extruder, 44 mm screws	100 kg/hr	Buhler Inc.
Vacuum top-coater	NA	AJ Mixing International
Vacuum bagging system	500 kg/hr	DeMarco

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Specific density
- Pellet durability (PDI)
- Particle size distribution
- Maximum oil absorption

FEEDING TRIALS

Feeding trials are undertaken for cold water species of freshwater and marine fish: Digestibility, attractants, fry screening, growth, ingredient evaluation and diet development.

Facilities comprise 180 recirculation tanks. These are partial reuse systems with approximately 30% make-up water per day.

Zeigler

P.O. Box 85, 400 Gardners Station Rd., Gardners, PA 17324, USA.

CONTACTS:

Tim Zeigler, V.P. Sales & Marketing

Priscilla Shirley, Sales Representative

website

"Zeigler specializes in feed mill franchising, process engineering, formulation and nutrition. ingredient sourcing and international logistics support. Zeigler conducts animal trials in conjunction with various leading universities and research facilities. Please contact us for more information. We are EU and ISO-9001 -2008 certified."

PELLET PHYSICAL QUALITY/ PROCESSING TESTS

- Water stability
- Pellet hardness
- Specific density
- Pellet durability (PDI)
- Color / Odor
- Mixer testing
- Particle size distribution
- Micro particle analysis

PROCESSING CAPABILITIES

TYPE	CAPACITY	MAKE
Twin Screw Extrusion	Commercial & Pilot Scale	Wenger
Single Screw Extrusion	Commercial Scale	N/A
Pelleting	Commercial & Pilot Scale	N/A
Crumbling/Sizing	Commercial & Pilot Scale	N/A
Flaking	Commercial & Pilot Scale	N/A
Mixing	Commercial & Pilot Scale	N/A
Top Coating	Commercial & Pilot Scale	N/A
Grinding	Commercial & Pilot Scale	N/A
Pulverizing	Pilot	N/A
Small Packaging	1 oz. to 25 lb	N/A
Bulk Packaging	25 lb. to Totes/TL	N/A
Irradiation	Pallet Quantities	N/A

RATES

Pilot Manufacturing rates are charged by time and materials. Commercial scale manufacturing: is charged per product.

Far left: Lee Leer, Project Manager/Manufacturing Technician, and Left: Angie Meeder, Zeigler's Quality Assurance Technician preparing feed.