## LIVESTOCK FEEDS & FEEDING









RICHARD O. KELLEMS D. C. CHURCH

## **Contents**

	Preface xi		Minerals 26	
Contributors xiii			Vitamins 28	
			Dietary Energy 29	
			Feeding Standards 32	
AR	RT I	Methods for Assessing Nutrient Con		
Introduction 1			of Feeds 36	
			Summary 38	
1	LIVESTOCK FEEDING 1 Richard O. Kellems and D.C. Church		References 38	
	Basis for Successful Feeding of Livestock 2	PAR	RT II	
	References 5	Fee	eds for Livestock	39
		4	FEEDSTUFFS	39
2.	THE GASTROINTESTINAL TRACT AND NUTRIENT UTILIZATION Richard O. Kellems and D.C. Church Classification of Various Digestive Systems 6		Richard O. Kellems and D.C. Church	
			Classification of Feedstuffs 39	
			Estimating Nutritional Value of a Feed 43	
			Nutrient Content of Major Feedstuff	
	Characteristics and Function of Digestive		Groups 46	
	Tract 8		Variability in Feedstuff Composition	46
	Avian Species 11		Other Factors Affecting Feed Quality	47
	Ruminant Species 12		Feed Manufacturing Terminology 50	)
	Relationship between Type of GI Tract and		Summary 53	
	Type of Diet Required 14		References 54	
	Summary 15 References 15			
	References 13	5	HIGH-ENERGY FEEDSTUFFS D.C. Church and Richard O. Kellems	55
3	NUTRIENTS: THEIR METABOLISM		Introduction 55	
	AND FEEDING STANDARDS 16		Cereal Grains 55	
	Richard O. Kellems and D.C. Church	·	Relative Feeding Values of Cereal	
	Water 16		Grains 71	
	Carbohydrates 18		Milling By-Products of Cereal Grains	72
	Protein 20		High-Carbohydrate Liquid Feeds 75	
	Lipids 24		By-Product Dry Feeds 79	

	Roots and Tubers 80		Silage Additives 159	
	Fats and Oils 81		Crop Residues 160	
	Garbage 84		Summary 163	
	Other Energy Sources 84		References 164	
	Summary 84			
	References 84	8	MINERAL AND VITAMIN SUPPLEMENTS	166
6	SUPPLEMENTAL PROTEIN		D.C. Church and Richard O. Kellems	
	SOURCES 86		Mineral Supplements 166	
	Richard O. Kellems and D.C. Church		Variation in Content and Utilization of	
	Introduction 86		Minerals in Natural Feedstuffs 172	
	Protein Sources 87		Vitamin Sources 174	
	Plant Protein Sources 87		Summary 178	
	Millfeed Protein Sources 97		References 178	
	Distillery and Brewery By-Products 98			
	Other Plant Protein Sources 98	9	FEED ADDITIVES	179
	Protein Supplements of Animal		D.C. Church and Richard O. Kellems	
	Origin 99		Introduction 179	
	Milk Products 101		Use of Feed Additives Classed	
	Marine Protein Sources 101		as Drugs 179	
	Miscellaneous Protein Sources 102		Summary 190	
	Nonprotein Nitrogen 104		References 190	
	Liquid Supplements 107		.,	
	Protein Solubility and Degradability	10	FEED LAWS AND LABELING	193
	by Microorganisms as Related to		Richard O. Kellems and D.C. Church	
	Ruminants 111		Labeling Regulations 193	
	Summary 113		Medicated Feeds 195	
	References 115		Summary 196	
			References 196	
7	ROUGHAGES 117			
	Richard O. Kellems and D.C. Church	11	FEED PROCESSING	198
	Nature of Roughages 118		Richard O. Kellems and D.C. Church	
	Basic Differences in Roughages 118		Introduction 198	
	Factors that Affect Roughage Utilization 118		Grain-Processing Methods 198 Roughage Processing 203	
	Pastures and Rangelands 119		Effect of Processing on Nutritive	
	Chemical Composition of Herbage 122		Value 206	
	Factors Affecting Forage Nutritive Value 126		Feed Processing for Nonruminant Species 208	
	Permanent Pastures and Rangeland 131		Grain Processing for Beef Cattle 210	
	Hay and Silage Making 134		Roughage Processing for Beef Cattle 2	11
	Assessment of Nutritive Value of Hays 140		Feed Processing for Dairy Cows 213	
	Nutritive Properties of Silages 149		Feed Processing for Sheep and Goats	214
	<del>-</del>		- ·	

High-Moisture Grain 215 Economics of Feed Processing and Preservation 217 Effect of Processing on Density 2 Oxidized Feed 221 Summary 221		14	FEEDING POULTRY W.B. Roush Introduction 291 Nutrient Requirements 291 Classes of Ration Components 295 Feedstuffs for Poultry 297	<b>291</b> 3
References 221  12 RATION FORMULATION	223		Feeding Management of Poultry 2 Summary 310 References 310	99
Harold W. Harpster and Danny G. F Introduction 223 Ration Balancing Process 223	ox .	15	FEEDING DAIRY COWS  David J. Schingoethe	313
Nutritional Goals and Sources of Information 223  Formulating Rations—Hand Methods 224  Feed Composition Values 225  Feed Formulas and Conversions Simple Ration Balancing 226  Calculating the Appropriate Level of Nutrients 229  Ration Evaluation—Worksheet Methods 229  Balancing Rations Using Computer Programs and Comprehensive Models 241	of Feed	16	REPLACEMENT HEIFERS	
Ration Formulation in the Future Summary 246 References 246	244		Mark Aseltine Introduction 329 The First Critical Days 329 The First 60 Days 330 Milk Replacer 330	
PART III Livestock Species 248			Starter Rations 332 Heifers: Weaning to Breeding 333 Gestation 336	3
13 FEEDING SWINE  Gary L. Cromwell  Introduction 248	248		Feeding Dairy Breed Steers for Beel References 340	338
Nutrients Required by Swine 248 Feedstuffs Used in Swine Diets 25 Processing Feeds 273 Feeding Management 274 Summary 289 References 289		17	FEEDING THE BEEF COW HER Jan Bowman and Bok Sowell Introduction 341 Biological Cycle and Requirements Forages for Beef Cattle 347 Grazina Management 348	

	Grazing Systems 350 Animal Requirements, Forage Resource	<b>5</b> 6	20	SHEEP NUTRITION Rodney Kott	402
	and Costs 352	, , , , , , , , , , , , , , , , , , ,		Introduction 402	
	Nutritional Management 352			Nutrient Needs 403	
	Supplementation with Nonstructural Carbohydrates 355			Body Condition Scoring 407  Ewe Nutrition 408	
	Calf Survival and Cow Nutrition 356			Lamb Nutrition 416	
	Nutritional Disorders 358				
	Summary 360			Growing and Finishing of Lambs 420 Potential Nutritional Problems 423	
	References 360			Feed Processing 424	
18	FEEDING GROWING-			Nutritional Management of Replacement Ewes 424	nt
10	FINISHING BEEF CATTLE	361		Range Ewe Nutrition 426	
	M.L. Galyean and G.C. Duff			Nutrition and Wool Production 426	
	Introduction 361			References 428	
	Cattle Types and Cattle Growth 361				
	Systems Used for Growing and Finishir Beef Cattle 364	ng	21	GOATS AND GOAT NUTRITION  J.E. Huston	430
	Managing Newly Received Cattle 36	7		Introduction 430	
	Starting Cattle on Feed 369			Feeding Behavior 430	
	Feed Bunk Management 371			Productivity of Goats 432	
	Finishing Diets 371			Nutritive Requirements 436	
	Anabolic Agents and Feed Additives 375 Metabolic Disorders 376			Feeding and Management 440	
				Summary 448	
	Summary 378			References 448	
	References 378				
	N.		22	FEEDING AND NUTRITION	
				OF THE DOG AND CAT	451
DΔD	T IV			Diane A. Hirakawa	
				Introduction 451	
	eding Other mesticated Species	381		Economic and Social Significance of Do and Cats 452	ogs
19	FEEDING HORSES	381		Nutrient Requirements of Dogs and Cats 452	
	Laurie Lawrence			Commercial Diets for Dogs and Cats	462
	The Digestive System 381			Feeding Through the Life Cycle 464	
	Nutrient Requirements 382			Selection and Evaluation of Pet Foods	467
	Feeds 387			Table Scraps and Supplementation 47	70
	Feeding Guidelines 394			Methods of Feeding 472	
	Common Feed-Related Problems in Horses 399			Two Common Nutritionally Responsive Disorders 472	
	Feeding Management 400			Summary 474	
	References 401			References 474	

FEEDING RABBITS 478 Luc Maertens Introduction 478 Characteristics of Commercial Rabbit Meat Production 478 Digestive System 478 Digestive Process 479 Feeding Behavior 481 Nutrient Requirements 483 Feedstuffs for Rabbits 490 Feeding Management 491 Practical Feeding 493 Health Problems 496

Feed Conversion 496 Summary 497 References 497

## **PART V**

**Appendix Tables and Glossary** 501

APPENDIX TABLES 501

**GLOSSARY 629** 

INDEX 639