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全国高等农业院校教材

English in Agricultural Science

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序　　言

我从事高校外语（主要是英语）教学已经48年了，其中在农业院校教了整整40年。作为新中国农业高校外语教学的从业者与见证人，使用过建国以来几乎所有的农业英语教材，也主编或主审了一两部部编教材：西北农学院陈式瑜主编、农业出版社出版的供农业院校动植物类各专业用《英语》（1965），沈阳农学院主编、农业出版社出版的《基础英语》（农林专业用）（1978），北京农业大学李鲸石教授主编、科学普及出版社出版的《农科综合英语》（1984，1985），南京农业大学俞保丽教授主编、王耀庭主审、中国农业出版社出版的《农科专业英语阅读教程》（1995）以及后来王耀庭主编的《农业科技英语写作教程》（1996）等等。任何教材都是受当时大纲与英语学与教水平、教育方针政策的历史局限的。这些教材都曾满足了当时时代的需求，但也都被或将会被新教材取而代之。

农科院校专业英语课早已从基础英语教学中被抽出来。目前，这门课一般由专业院系安排本院系教师教。主要由于缺乏恰当教材，教师一般自选本专业学术专著章节或论文阅读，阅读活动也常只是英译汉。新《大学英语教学大纲》规定专业英语为必修课后，各高校正在或将要有计划地编写出版一批保证四年不断线的应用提高阶段的专业英语和高级英语教材。现在，中国农业出版社在全国率先推出生命科学类《农业科技英语》，对全国农业院校的专业英语教学是雪中送炭，可喜可贺。

侯广旭主编的《农业科技英语》（生命科学类）给我留下的最深印象是：作为英语教师，编者们，尤其是主编，能熟练得把握动植物农业科技的布局、沟通多学科相关科技概念，能用与课文同样地道的英语准确、灵活地概括科技知识，给随机选取于原版农业科技著作的语篇编出丰富的多项选择等阅读题，既符合英语教学及编题原则，又运载了广博的科技信息。这种扎实语言及教学知识与丰富科技知识的完美结合在目前出版的各类科技英语教材中也是少有的（如各类教材仍很少编写多项选择阅读理解题）。

编教材，我们这一代人当年靠的全是“craftsmanship”；而广旭这一代人不光有手工操作的精雕细刻，还借助于“high - tech”。如，要实现所有词汇练习的中心词来自课文，但其农科用例又不重复课文，我们这一代人当年不知积累

了多少年的卡片后方可做到的，今天，在电脑上利用强大的农业科技光盘数据库，敲敲键盘，几天即可完成——而且得到的是恰当、精粹的例证。

《农业科技英语》(生命科学类)，以其对多学科科技知识的灵活操纵、对教材编写原则的合理运用以及对英语的地道使用，是科技英语教学领域具有开拓意义的教材，是农业高校外语教材建设的一项令人瞩目的成就。我希望这部好书能为培养较高科技与外语素质的跨世纪人才充分发挥作用。

是为序。

王耀庭

1999年6月10日

前　言

《农业科技英语》（生命科学类）是中华农业科教基金资助项目，农业部“九五”部级重点教材。我们依据新《大学英语教学大纲》要求，编写了这部供全国农业院校生命科学类各专业三、四年级专业英语课用的教材，旨在培养阅读农业科技原版书刊的能力及农业科技方面一定的口笔语交际与翻译能力。

全书二十五单元覆盖植物科学、遗传育种、土壤肥料、植保农药、大田作物栽培、果蔬园艺、食品科技、动物行为、畜牧兽医等学科及农业高教、科技职业等题材。突出生命科学类各农科专业共同基础课和常用农科概念与知识及常用农科词汇。课文选文由以英语为母语的科学家编著的农科本科精品教材为主，以报刊科技评论、农科院校介绍、使用说明、书籍内容简介等多种文体样式的真实材料为辅。

除保留一些语言点供学生思考或自查之外，我们对农科术语、概念、农科常用词语及其它科技与普通词语等用汉语做了注释。重译或首译了一些新词语。我们把课文间复现的、注释过的某些词语编成索引与原注释呼应，以免查不到而影响阅读兴趣。

多项选择阅读理解题贯通相关学科的规律和概念，覆盖多种阅读亚技巧及其它抽象思维能力。句子层次阅读理解题避免了单一性，着重于攻克理解或翻译难点，培养学生对语言的细微观察能力、理解能力和翻译能力。篇章层次的阅读理解题也可提高学生的口语或写作能力。此外，语言知识的巩固与学习又体现在 CLOZE 阅读练习中。

本书主要编者完成任务的情况是：侯广旭——总体构思，课文选材与整理，前言，写给教师的话；全部 QUESTION II、III、IV，多数 QUESTION I 与 V，较多 NOTES。刘延秀——较多 NOTES 与较多 QUESTION I。张友琴——全部 CLOZE、部分 NOTES 与 QUESTION I（以上练习编写大多包括答案）。

全国高等农业院校教学指导委员会人文与社会科学学科组组长、华中农业大学王绪朗教授和副组长、外语学科组组长、上海水产大学童吉美教授对书稿进行了认真的审阅并提出宝贵意见。此前童教授提出了《农业科技英语》按生命科学类、农业经贸类与农业机械类分三套编写的创意。编写工作得到南京农

业大学教务处长蒋宝庆研究员大力支持，得到人文学院盛邦耀院长、英语系资深教授王耀庭和俞保丽、邓昭春副主任的热情关心。王廉军主任除亲自参编外，为编写工作创造了条件。英语系孙勇、徐健、程康等同学承担了大量的校对工作。在此，谨向以上这些领导、师长和同学们致以真切的谢意。

我们从国外原版农科教科书与专著中选用了各种材料作为课文，有的用原文，有的加以增删或改编，主要为了保持全书题序层次、内容与风格的呼应、统一与简练。除节选、改编幅度较大者外，文后出处简注未一一标明"adapted"之类的词。另外，个别练习的编写参考或选用了上述书籍内容。我们将这些书籍均列于书后的"BIBLIOGRAPHY"中，并向其编审者与出版者谨致谢意。

生命科学类《农业科技英语》的教材编写是一种尝试，还有许多问题有待探讨，敬请广大师生批评指教。

编　者

1999年6月5日

写给教师的话

1. 指导思想

到了20世纪90年代后期，科技英语教材建设已产生巨大飞跃：取材上，已从科普短文或编者撰写的小会话等发展到原版教科书的真实选文。结构上，已从语音、词汇、语法、句型操练、句子翻译为主的基础英语与科技英语的综合型，发展到利用多项选择、综合填充、篇章理解问答、语段英汉互译及写作练习统揽全篇的高级阅读型；从语言信息与科技信息各为一档的分离“信道”传递，发展到多种语言技巧与丰富科技知识的融合。编者素质也由外语素质与科技素质的难处一身，发展成复合型：熟悉科技知识与英语阅读理论、大纲与教材开发、测试、写作等学科知识，能“内行”地与相关科技概念、理论形成多角度、全方位自由联想，能用与课文同样地道的英语表述、概括科技概念与知识；能创造性地设计课文、师生三者互动式科技语言的理解与应用活动。编写手段上，已由过去的手工操作，发展到充分利用电脑网络、光盘资料等来高效地索取、处理、加工信息。我们在《农业科技英语》(生命科学类）编写的具体操作中，努力跟上时代的步伐。

专业英语是大学英语教学的重要组成部分，是促进学生完成从学习阶段过渡到应用阶段的有效途径。我们的教材是从目前几乎没有真正科技英语的基础英语阅读进入到具体专业学术专著类应用性阅读的过渡教材。考虑到农业科学的学科结构、本科教科书和普及性科技杂志与更专门的学术论文专著的难度差别、农科大学生的英语水平与师资状况，我们认为生命科学类各农科专业应使用一套全国统编教材打下科技阅读能力基础。这样也有利于发挥英语教师和专业教师各自的特长，即前者在讲解难句、分析语篇、训练阅读技巧上是轻车熟路；而后者在导读本专业文献及汉译上有一技之长。

传统农科英语教材取材的科普文体实际上更接近于普通文体，与英美大学生所读的语言流畅但又不失严谨的教科书以及科技人员实际所读的其它科技文体（包括应用文体）有较大区别。虽有部分术语重合，但在行话、词汇量、信息量上差别很大。随着时代的发展，训练我国大学生CET4后的科技英语阅读能力要求我们从阅读既真实又易读的教科书选文开始。本科生精品教科书在内容和语言上都照顾学生[1]。里面有科技英语从词到篇、从概念到理论的最佳配比，是过渡到学术论文、专著类高级阅读前的必读之物。

很多农业科技知识都具有普及意义。跨世纪的农业大国农科大学生，无论所学何种专业，都应在其知识结构中融入一定量的农业科技各主要领域的基础知识和常用概念，了解现代农业科技的发展与存在的问题，培养专业兴趣、意识与敬业精神。当这种知识以现代科技最强大的载体“英语”为工具运入课堂时，学生就会扩大通用于各专业的次科技词汇量，熟悉科技文体，提高阅读能力。正像许国璋先生生前常说的那样，“阅读首先是吸收

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[1] Raven, Peter H. & Johnson, George B., 1991, *Understanding Biology* (2nd ed.), Mosby-Year Book, Inc.: vi-vii; Avila, Vernon L. 1992, *Biology: A Human Endeavor*, Bookmark Publishers: xxii.

知识，吸收知识的过程中自然而然地就吸收了语言。”[2] 另外，属应用生物学范畴的农业科学是高级英语阅读的重要题材范畴之一。GRE（General Test），GMAT 等的阅读部分都把生物学列为四大取材［及对考生知识的预设（presupposition）］领域之一，好多选文涉及农业科学。

2．主要编写原则

2．1 覆盖面广，可读性强

如前言所示，本教材广泛而平衡地覆盖了生命科学类农业科学的各主要学科。同时，我们还兼顾可读性。对较难而又不可回避的题材，我们尽量到非专业用、共同课（Core Course）教科书中选材，尽量使科技内容与我国大学生现状相适应，使具有高中化学、生物、物理课基础的大学生不存在基础知识上的理解问题（这也是农科一般读物的特点[3]）。知识性、趣味性及时代感兼而有之等特点将使学生欣赏到现代农业科学的宏伟和微妙。农业科学关系到人类的命运与前途，展示着自然和生命的美丽、和谐与奥妙。水和无机物如何超过物理极限被推（吸）到离地数百英尺以上的树梢[4]，470 多年前的种子为何仍能发芽等植物生理问题[5] 都会吸引住任何专业的学生。营养学、遗传学、动物卫生、家庭园艺、食品加工与贮存等学科的很多实用而有趣的问题都与特别注意吃、穿、健康与生活环境的现代人关系密切。当学生发现很多原来学过的生活词汇被巧妙地腾挪变通用来表达农科意义（见下文）时，他们会感到农科英语的语言之妙，妙不可言。当他们能读懂英美农科大学生使用的通俗易懂的（reader-friendly）教科书时，他们会感到心中开了一扇通向异域乃至世界科技文化的窗口，有了一点“世界归属”[6] 的感觉。这些感觉会减弱、取代对科技英语的畏惧感，增强英语学习的信心。

2．2 词汇丰富，注释详尽

广而平衡的学科覆盖与选材中的词汇调查为农科常用词汇的包容与强调提供了前提。各专业学生将来阅读、译写各类农科资料都会最高频率地遇到这些词汇，大大降低查词典的频率。

除保留一些语言点供学生思考或自查之外，我们对农科术语（包括有随文定义的）、概念、农科常用词（包括普通词的农科意义或同形异义），农业机构等百科性词语等用汉语做了注释。重译或首译了一些新词新语。

农业科学是综合性极强的科学。好多“行话”（jargon）与日常生活关系紧密，如“overwinter 越冬”，“home garden 家庭菜园”和“hotbed 温床”。同义现象十分丰富：“grain crop”和“cereal crop”都指“谷类作物”，“pig”、“hog”和“swine”都可指“猪”，“surface soil”和“top soil”都指“表土”，“necropsy”和“autopsy” 都指“尸体剖检”，“in estrus”、“in（on，at）heat”和“in season”都指“发情”。一词多义、同形异义现象相当多，如下列普通词的农科意义：“club 密穗小麦”，“stone 果核”，“check 破壳蛋”，“hoop 干酪模子”，“finish 肥育”。这类词有时进入短语，如“dressed bird 白条鸡”。普通词多个农科意义有时同时出现：“litter”和

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[2]刘润清，1995，许国璋教授与英语教育，《外语教学与研究》1995 年第一期：8～13。

[3] Hewitt, E. C. & Brazier, D. J., 1986, *Agricultural Science* (3^{rd} ed.), London: William Collins Sons & Co. Ltd. : xii.

[4] Avila, Vernon L. 1992, *Biology: A Human Endeavor*, Bookmark Publishers: 491

[5] Raven, Peter H. & Johnson, George B., 1991, *Understanding Biology* (2^{nd} ed.), Mosby-Year Book, Inc. : 705

[6]高一虹，1994，生产性双语现象考察，《外语教学与研究》第一期：59～64。

"broiler"在"Swine Reproduction"和"Food Science"中分别指"一窝仔猪"和"烤焙用具",而在"Broiler and Layer Industry"中分别指"垫草"和"肉仔鸡"。"service"在"Department of Plant And Soil Science, Montana State University"等课文中指"服务部(局、处)、政府部门",而在"Swine Management"中指"配种"。"crop"在多数课文里指"庄稼",而在"Swine Management"中指"一年产仔数",在"Dairy Cow Unified Score Card"中指"牛脊肉"。"profile"在"Soils Management"中指"剖面",而在"The Process of Digestion and the Foods We Need"中指"数据图表"。"pellet"在"The Process of Digestion and the Foods We Need"中指"药丸",而在"Swine Reproduction"中指"颗粒冷冻精液"。有些普通词在农科上虽未有大的意义跳跃,但有其严谨的科技意义及其汉语说法,如,"browning 褐变","trace 痕量","quarter 四开胴","yield 得量(产量与原料的百分比)"。另外,乘接或不乘接上下文的省略说法也不少,如"block = butcher's block 肉案","soft red winter = soft red winter wheat 软粒红冬小麦","forage = forage sorghum(整株)饲用高粱"(forage 也指"饲草")。这类词语都有注释。但对普通多义共现,一般不注。如"advances"在"Advances in Genetics"中指"进展",而在"Animal Behavior"中指(对异性动物的)"挑逗",后一意思被编入问题。

我们在注释上一丝不苟。如有些科技词之间只有一字(母)之差,一不留神,极易出错,如,"rennin 凝乳素"和"renin 肾素";"sucrose"(蔗糖)和"sucrase"(蔗糖酶)。

2.3 突出阅读理解

我们在一半以上的课文上借鉴了国内一些优秀泛读教材的作法,即用篇幅长些,而文字浅些的材料来帮助学生拓宽知识面,扩大词汇量,增强语感。

多项选择阅读理解题贯通相关学科的规律和概念,富于挑战性,覆盖多种阅读亚技巧(辨别事实,注意细节,综合分析主题、目的、篇章结构,推理判断,进一步应用、体味格调等)及其它抽象思维能力。我们知道,GRE 等考试的人文、社科、生物、物理等阅读选文的问题是由各专业专家分头编写、又经专门审定者在不知答案情况下对选文、问题、最佳选择项、干扰项的合理性、实用性进行试答、分析、测试后取舍、修订而成的[7]。而我们的教材练习题是由英语教师编写的。就是知道不照搬原文词语、问题有中心、选择项长度与性质一致等编题原则,"但给每题配上合乎要求的四个选择项,往往绝非易事"[8]。有些阅读理解题本身就是科技习题或考题。在这方面我们克服的困难是可想而知的。

句子层次阅读理解题形式多样,专攻理解或翻译难点。篇章层次的阅读理解题也有利于提高学生的口语与写作能力。Cloze 既照顾到词语搭配、惯用法、结构等方面的语言学习,又刺激学生依据已掌握的语言与科技知识猜测词义、读懂篇章。

3. 教学建议

限于学时数,我们应尽量让学生在课外通读课文,并完成全部或部分阅读练习题的笔头或口头作业。课堂的宝贵时间要精打细算,主要用于口头检查作业(包括说写)和阅读任务,讲解词句难点、科技背景知识、阅读、翻译技巧等。切忌面面俱到,更不要把整篇课文拿到课堂上逐句阅读。书中练习可取舍、增订。

我们要根据学生水平尽量用英语组织课堂教学,使学生以英语为媒体与教师及课文交

[7] The GRE Board, 1990, *Practicing to Take the GRE Test*, Princeton: Educational Testing Service: 9.

[8] 刘龙根,孙怀庆,1997,《外语测试学导论》,吉林大学出版社,长春:139。

互作用，锻炼阅读思维能力。同时，注意发挥英译汉更适合于理解难句及与汉语储存的科技概念准确沟通的作用。如，本书中常用的“management”、“operation”、“practice”、“expectation”、“performance”这类词，学生往往觉得都认识，但当在具体上下文中被请来翻译成汉语时，常拿不出恰当的说法。专业性很强的工具书也不能代替我们的想象力、创造力。如“performance record”，《英汉现代农业科技大词典》（1118）的译文是“生产性能测定，成绩测定记录”，而在“Broiler and Layer Industry”中应译成“产蛋力记录”，在其它课文中则译成“产乳力记录”、“产毛力记录”等为好。对于含有成语、多义词及其它复杂或不容易看清的结构，学生往往觉得懂了，而当问及在汉语里是何意义或怎样译时，常模棱两可。这种情况不可等闲视为所谓“直接用英语思维”的必然的、无所谓的副作用或是语言不可译性使然。它对词汇的掌握与阅读能力的培养是有害的。对于所有人文、社科与科技教育均在汉语媒介中完成的我们来说，即便使用汉语阅读尚且常存在科技概念含义、界定模糊的情况，何况换一种异邦语言呢？在英语里，我们缺乏母语本能优势，熟练程度、思维效度、“内存”、反映速度都大受影响。因此，当我们遇到阅读难点时有必要使用汉语来“一语道破”，“诊疗”理解症结，扫清阅读上的拦路虎。另外，就“Learner Needs”、“Teaching Objectives”与“Language Proficiency”来说，翻译能力又是不可缺的。但不应单独用英译汉来逐字逐句或“长篇大论”地训练阅读理解。那样就减少了学生能胜任的与相关科技概念的直接相互作用，精力过多消耗在寻求汉语表达上，不利于提高阅读速度，会养成依赖汉语的阅读习惯，妨碍其它语言技巧和抽象思维能力的提高。

图式知识阅读理论认为，读者对课文内容及修辞结构的知识越多，阅读理解就越透彻。只有教师有课文所需图式知识，才能启动学生的图式知识，从而帮助他们自下而上（从最小的文字单位开始，解释课文，充实、修正固有的图式知识）或同时自上而下（利用已有图式知识，边阅读，边推测与验证）地阅读，达到透彻的理解[9]。教师可介绍背景知识、关键术语或概念来开始一篇课文的阅读，以此启动学生的图式知识。生命科学类农业科技往往基础课与专业基础课教材难读，而与农业生产相关的专业课教材反倒容易读。内容上如此，语言上亦然。因此，教师可根据自己的图式知识对课文进行选择、取舍或重新排序。童吉美教授曾说：“专业英语老师们在书中哪怕能找到一些适合本专业的单元，这本书也就有了价值。”

本教材基本覆盖了生物类各农科专业。因此，英语教师使用本教材时，可利用书后所列课文选文的原始文献，做些背景阅读，或参加“专业知识培训”[10]。除了专业人员外，学生完全有可能是我们的老师，我们要放下架子，转变观念。进入课堂，师生即风雨同舟，互相帮助，共同攻克专业英语之难关。现在，英语师资的源头——外语专业教学内容普遍缺少科技知识的问题已经得到外语界的注意[11]。北京外国语大学刘润清教授在一次大学英语研讨会上说，“今后外语教学的发展趋势是，要求教师增加百科知识，大学英语教师更应这样做。你们面临的学生在专业知识上远远好于你们。如果你们能略懂一些他们的专业，教起书来就‘神气多了’。”[12]

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[9]张维友，1995，图式知识与阅读理解，《外语界》第二期：5~8。

[10]编者，1999，编者的话，《外语教学与研究》第一期：1~2。

[11]北方课题组，1998，关于外语专业教育改革的思考，《外语教学与研究》第三期：5~9。

[12]刘润清，1999，外语教学研究的发展趋势，《外语教学与研究》1999年第一期：7~12。

在以英语为教育媒体的一些国外大学里，专业学习与英语是结合在一起的。在我国，两者是分离的。不过，我们在两者的结合与互动上是大有作为的。浙江大学邵永真教授多次强调“要提倡在高年级专业课教学中每学期至少有一两门课程使用英语教科书或参考书...，对学生的文献阅读要规定相当量的英语文献，要求学生用英语写毕业论文摘要，以利于学生完成从基础学习到实际应用的转换”[13]。

4. 结语

教材出版后，欢迎广大师生多提意见。我们力求为全面推动21世纪外语教学再上新台阶，为培养具有较高科技与外语素质的跨世纪人才做出应有的贡献。

侯广旭

1999年6月5日

[13]邵永真，1998，大学英语课堂教学研讨会发言摘要，1998年8月于江苏昆山市；黄建滨，邵永真，1998，大学英语教学改革的出路，《外语界》第四期：20~22。

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Unit One

THE FUTURE OF AGRICULTURE

One of the greatest and most immediate challenges facing today's world is to produce enough food to feed its expanding population. Even though it is estimated that world food production has expanded 2.6 times since 1950—more rapidly than the human population—virtually all the lands that can be cultivated are already under cultivation. A quarter of the world's topsoil has been lost from agricultural lands during this period, and the human population is continuing to grow explosively. Much of the world is populated by very large numbers of hungry people who are rapidly destroying the sustainable productivity of the lands they inhabit; at the same time, consumption in industrialized countries such as the United States, running at 20 to 30 times the rate in developing countries, is having an even greater adverse effect on the future of humanity. In the face of these massive problems, we need to consider what the prospects are for increased agricultural productivity in the future, and what we can do to improve these prospects.

For a start, we are going to have to identify more kinds of crops. Nearly all of the major crops now grown in the world have been cultivated for hundreds or even thousands of years. Only a few, including rubber and oil palms, have entered widespread cultivation since 1800. One key feature for which nearly all of our important crops were first selected was ease of growth by relatively simple methods.

How many plants do we use at present? Just three species—rice, wheat, and corn—supply more than half of all human energy requirements; only about 150 kinds of plants are used extensively; and only about 5 000 have ever been used for food. It is estimated that there may be tens of thousands of additional kinds of plants, among the world total of some 250 000 species, that could be used for human food if their properties were fully explored and they were brought into cultivation. There are also many uses for plants other than for food. Oral contraceptives were produced from Mexican yams for many years; the muscle relaxants used in surgery worldwide came from curare, an Amazonian vine used traditionally to poison darts used in hunting; and the cure for Hodgkin's disease was developed in the early 1970s from the rosy periwinkle, a widely cultivated plant native to Madagascar.

The reasons for which we select new crops now are often very different from those which appealed to our ancestors who developed agriculture, living as they did in small groups around the foothills of the Near East or on the temperate slopes of the mountains in Mexico. Standards of cultivation have changed, and we use many products from plants—for example, oils, drugs, and other chemicals—that often would not have led to their cultivation earlier. In a time when human activities threaten to drive many of the world's plants and other organisms to extinction during our lifetimes and those of our children, we need to search systematically for new and useful crops that fit the multiple needs of modern society in ways that would not have been considered earlier. We must begin more diligent efforts to find and bring into cultivation more kinds of useful plants before they are gone forever.

In improving the world food supply, the most promising strategy is to improve the productivity of crops that are already being grown on lands that are under cultivation. Much of the improvement in food production must take place in the tropics and subtropics, where a rapidly growing majority of the world's people already live, including most of those enduring a life of extreme poverty. These people can not be fed by exports from the industrial nations, which contribute only about 8% of their total food at present and where agricultural lands are already heavily exploited.

During the 1950s and 1960s, the so-called Green Revolution took place. This revolution depended on the development of new, improved strains of wheat and rice at international centers that were organized by groups such as the Rockefeller and Ford foundations, with the assistance of many other agencies and of governments. As a result of the efforts made at these centers, the production of wheat in Mexico increased nearly 10-fold between 1950 and 1970, and Mexico temporarily became an exporter of wheat rather than an importer. During the same decades, food production in India was largely able to outstrip even a population growth of approximately 2.3% annually, and China became self-sufficient in food.

Despite the apparent success of the Green Revolution, the improvements were limited. The agricultural techniques that were employed required the expenditure of large amounts of energy and abundant supplies of fertilizers, pesticides, and herbicides, as well as adequate machinery. For example, in the United States it requires about 1 000 times as much energy to produce the same amount of wheat that results from traditional farming methods in India. Introducing industrial-country methods obviously increases the yield, but who will pay the bill? Energy prices are often held at artificially low levels in developing countries, so it may actually be more expensive for a poor rural farmer to grow an equivalent amount of grain than for a large-scale farmer using developed-world technology. In this respect, the introduction of Green Revolution methods in some regions has actually worsened poverty for many of the people and lessened their access to food, fuel, and other commodities on which they depend.

Certain nutritional problems have also arisen in connection with the Green Revolution. The overconcentration on cereal crops has tended to lower the production of other nutritionally important plants, including legumes, oilseeds, and vegetables of all kinds. The reason that legumes and cereals are often nutritionally combined is that they provide a balanced set of amino acids required by human beings for proper growth. The varied strains of crops that are grown on small farms may also be driven out by fewer kinds of modern strains and fewer crops, which produce a better yield if large-scale inputs of chemicals and the use of machinery are possible. Despite these short-term advantages, the loss of the unique, traditional strains of crops presently cultivated by small, rural farmers throughout the world may ultimately prevent the particular crop plants from being able to grow in less favorable habitats or to withstand important diseases in the long run. Monoculture—the exclusive cultivation of a single crop over wide areas—is an efficient way to use certain kinds of soils, but it carries the risk of an entire crop being destroyed with the appearance of a single pest species or disease.

In improving the world food supply, the most promising strategy is to improve the productivity of crops that are already being grown on lands that are under cultivation. There are relatively few parts of the world where additional land exists that can be brought into cultivation using currently available technology. Biologists have a crucial role to play in the improvement of crops and in the development of new ones. Traditional methods of plant breeding and selection must be applied fully to many crops of importance in the tropics and subtropics in addition to wheat, corn, and rice. Genetic engineering techniques are being applied extensively to crop plants and, to some extent, to animals, and these techniques offer great promise for the future. For example, it will be possible to produce plants that are resistant to specific herbicides, which can therefore be applied much more effectively to crops for weed control . It will soon be possible, through the methods of genetic engineering, to produce new strains of plants that will grow successfully in areas where the crop could not grow before. Eventually it will also be possible to introduce desirable characteristics into important crop plants, such as the ability to fix nitrogen, carry out C_4 photosynthesis, or produce substances that deter pests and diseases in abundance. The ability to transfer genes between organisms will be of great importance in the improvement of crop plants before the twentieth century draws to a close.

The oceans were once regarded as an inexhaustible source of food, but overexploitation of their resources is actually limiting the world catch from year to year, while these catches are costing more in terms of energy. It has been estimated that the mismanagement of fisheries, mainly through overfishing, local pollution, and the destruction of fish breeding and feeding grounds, has already lowered the catch of fish in the sea by about 20% from its maximum levels. The decline in the numbers of whales in the oceans of the world is a tragic and well-known example of the way fisheries have been and are being destroyed.

The development of new kinds of food, such as microorganisms grown in culture in nutrient solutions, should definitely be pursued. For example, the photosynthetic, nitrogen-fixing cyanobacterium *Spirulina* is being used in this way, with experimentation under way in several countries to see whether it can be developed into a commercial food source. Masses of this bacterium are used traditionally as food in Africa, Mexico, and other regions. *Spirulina* thrives in very alkaline water and has a higher protein content than do soybeans; the ponds in which it grows are 10 times more productive, on the average, than are wheat fields. Ultimately the enrichment of human food through protein-rich concentrates of microorganisms will provide important nutritional supplements to our diets. But there are psychological barriers that must be overcome to persuade people to eat such foods, and the processes required to produce them tend to be energy-expensive.

From *Understanding Biology* (2nd ed.).

Notes

topsoil 表层土,土壤耕种层
oil palm 油棕
oral contraceptive/--ˌkɔntrəˈseptɪve/口服避孕药
yam/jæm/山药,甘薯,山芋
relaxant 弛缓药
curare/kjuˈrɑːrɪ/箭毒,马钱子
Amazonian/ˌæməˈzəunjən/亚马孙河的,亚马孙河流域的
Hodgkin's disease/ˈhɔdʒkɪn--/何杰金氏病(淋巴肉芽肿)
rosy periwinkle/--ˈperɪˌwɪŋkl/粉色蔓长春花
Madagascar/ˌmædəˈgæskə/马达加斯加
strain 品系
the Rockefeller Foundation 洛克菲勒基金会
the Ford Foundation 福特基金会
fold *suf*. . . . 倍(接在数词后)
outstrip/autˈstrɪp/ *v*. 超越
pesticide /ˈpestɪsaɪd/ 杀虫剂,农药
herbicide /ˈhəːbɪsaɪd/ 除草剂
cereal /ˈsɪərɪəl/ *n*. 谷物; *a*. 谷类的
legume /ˈlegjuːm/ 豆科植物
amino acid /əˈmiːnəu--/ 氨基酸
habitat (动植物的)生境,栖息地
monoculture 单种栽培
to fix nitrogen 固氮
photosynthesis/ˌfəutəuˈsɪnθɪsɪs/光合作用
C_4 photosynthesis 碳四光合作用
deter/dɪˈtəː/ *v*. 阻拦,威慑
catch *n*. 渔获量,捕获量
Spirulina/ˌspɪrəˈlɪnə/螺旋藻属
alkaline/ˈælkəlaɪn/碱的,碱性的
cyanobacterium/ˌsaɪənəubækˈtɪərɪəm/蓝藻,蓝细菌