链长制的衍化趋势与赋能路径
——以绿色低碳农业产业链为例

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摘 要：链长制作为一项地方政府主导的产业制度创新，为农业产业链由“效率优先”向“效率、安全与绿色低碳并行”转型提供了有效保障。本文通过梳理链长制的肇始、扩散、发展和成熟的演化历程，明确链长制正不断向有为“链长”的方向演化和发展，进而分析总结绿色低碳农业产业链的由来、内涵与特征，揭示打造绿色低碳农业产业链的现实背景。在此基础上，结合绿色低碳农业产业链的“外部竞争有力、主体协同有序、韧性持续增强、生态循环增值”打造目标，深入分析其面临的竞争力较弱、协同度较低、韧性不足和生态增值乏力等现实困境。最终，从有为“链长”的功能视角出发，在创新链、资金链、标准链、信息链、供应链和价值链等方面提出链长制赋能绿色低碳农业产业链的具体路径。

关键词：链长制 绿色低碳农业产业链 有为“链长” 产业转型升级

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加快农业全产业链建设，不仅是稳步推进乡村振兴战略和加快建设农业强国的有力抓手，也是实现“双碳”目标的基础支撑。为此，《“十四五”全国农业绿色发展规划》强调要“打造绿色低碳农业产业链”。然而，当前绿色低碳农业产业链面临竞争力较弱、协同度较低、韧性不足和生态增值乏力等现实困境，单纯依靠市场自动调节难以打破这些桎梏，亟需政府干预的补充以纠正“市场失灵”，从而更好地实现市场有效配置（黄先海、宋学印，2021）。链长制作为我国特色制度优势与市场化要素配置体系融合创新的产物，能够推动有效市场和有为政府更好结合（高杨等，2022）。在此背景下，2021年5月，农业农村部印发《关于加快农业全产业链培育发展的指导意见》，首次提出要开展农业全产业链链长制试点，以实现农业全产业链绿色低碳化发展。那么，链长制如何赋能绿色低碳农业产业链？

为解答该问题，本文首先通过梳理链长制形成的四阶段历程厘清其演化趋势和发展方向，进

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而在总结绿色低碳农业产业链的由来、内涵与特征的基础上，结合绿色低碳农业产业链的打造目标分析其现实困境。在此基础上，深入探究链长制赋能绿色低碳农业产业链的具体路径。

本文力图在以下几个方面作出贡献：第一，基于链长制肇始、扩散、发展与成熟四阶段历程，明确了链长制的演化趋势和未来发展方向，丰富了链长制的理论理解和相关研究；第二，从绿色低碳农业产业链出发，探讨绿色低碳农业产业链的由来、内涵与特征，揭示绿色低碳农业产业链的现实背景，在考虑“外部竞争有力、主体协同有序、韧性持续增强、生态循环增值”的打造目标基础上，深入分析打造困境，为更好地实现绿色低碳农业产业链打造目标提供了理论解释和现实依据；第三，遵循绿色低碳农业产业链的打造目标，从有为链长的功能视角，在创新链、资金链、标准链、信息链、供应链和价值链等方面探讨有为“链长”赋能绿色低碳农业产业链的具体路径，这使得本研究更具现实和政策意义。

一、链长制何以形成：肇始、扩散、发展与成熟

基于制度经济学视角，链长制在内外动因综合作用下发生传统产业制度变迁，归根结底是基于弥补市场发育不足、维持市场机制正常运行的合理需要而推出的一种地方政府主导的产业管理新制度新方法（刘志彪、孔令池，2021）。在现有科层组织基础上，链长制建立的扁平化协调机制不仅有利于加强多领域、多部门的横向联系，突破科层内部纵向结构，还能降低管理成本，提高治理覆盖面（梁小军、胡多，2022）。链长制作为一种制度变迁的产物并不会凭空产生，那么链长制何以形成？

（一）肇始阶段（2017—2018年）：效率为先，主要布局在工业

改革开放以来，我国通过设立开发区的方式，大幅吸引外资，引进国外先进技术，借鉴国外管理经验，承接国际产业转移，促进了经济高速发展（盛朝迅，2022）。根据产业集聚理论，开发区作为改革开放的排头兵，能够不断形成新的产业集聚效应和增长动力，通过规模经济和学习效应对所在区域产生正外部性（刘修岩，2009）。然而，在对产业效率和高速发展的追求下，开发区产业过度集聚易造成“产业同构”现象，陷入“成也集聚，败也集聚”的困局（屠年松、龚凯翔，2022）。

在土地与能耗等指标接近饱和、产业竞争白热化的背景下，如何遵循产业链运行规律，将以开发区为支点的产业聚合、协同、共生提升到新层次，成为重新思考开发区发展转型之路的题中之义。根据波特的竞争优势理论（Porter，1990），要把一个区域内劳动、资本、土地等生产要素转化为竞争优势，关键在于是否具有较强的整合这些生产要素的能力。在此现实背景和理论逻辑下，政府通过行政命令、法律法规等强制性手段整合、统筹区域内生产要素，进而引发强制性制度变迁，链长制应运而生。

2017年底，长沙市政府强调“以产业链建设为抓手，推动经济高质量发展”，提出“由市级领导

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担任各省级以上开发区产业链‘链长’”，“链长”一词首次出现在正式报道中[①]。次年4月，湖南省湘潭市为推进区域产业高质量发展，首创地方主导的链长制。随后，湖南省级领导逐渐开始参与“链长”的相关工作。省级领导的重视和介入，对于链长制类似于一种“催化剂”，不仅能够有效降低各部门、各地区协商合作成本，还便于统筹各种要素资源，形成不同部门和地区共同推动区域产业链高质量发展的合力。与此同时，辽宁省盘锦市也以开发区为主阵地，围绕高质量发展根本要求，启动链长制，以引领产业向高端化、规模化、集群化发展，实现新旧动能的有序转换。

在肇始阶段，链长制强调效率为先，主要布局在开发区的工业制造业，以提升产业链竞争力、推进产业转型升级和高质量发展为核心主题，其“高位推动”的机制手段初露锋芒。

（二）扩散阶段（2019—2020年）：效率与安全并行，快速向其他产业渗透

1.“外患”：产业链自主可控性与效率的矛盾

逆全球化愈演愈烈和中美贸易摩擦不断升级，实质表现于产业链上：首先，产业链被“打断”。我国对美国出口市场依赖度比较高的企业，面临加征关税难以消化、出口成本骤增的困境，可能发生产业转移。同时，我国劳动密集型产业外国直接投资流失，亦会造成产业转移和贸易转移，最终导致整个产业链出现断点。其次，产业链被“桎梏”。中美贸易摩擦的核心在于科学技术和优秀人才的争夺，遏制我国高科技产业发展等（刘志彪、凌永辉，2021）。当我国关键核心技术面临“卡脖子”的尴尬局面，科技资源出现缺口时，相当一部分产业链外循环难以为继，产业链出现内倾化趋势。

“覆巢之下，焉有完卵”。可以看出，产业链安全与稳定逐渐成为我国产业链重塑的主题。然而，产业链自主可控性的提高可能会导致生产效率的下降。因此，如何善用社会主义市场经济条件下的新型举国体制，发挥超大规模市场优势，以畅通痛点、连接断点为“标的”，建设更高附加值、更具韧性的产业链，缓解我国产业链自主权的失控与创新性的损害，实现安全与效率的平衡，成为亟待解决的问题。在此背景下，政府根据当前国际形势变化作出一系列决策，推动制度变革。

2019年8月，浙江省为应对中美贸易摩擦和开展“六稳”工作，最早开始在全省范围内、系统化普遍化推进链长制，由开发区所在市（县、区）的党政主要领导担任“链长”，以充分发挥地方行政主官的协调作用。链长制在浙江省的实践成果有目共睹：一是以开发区为支点撬动了浙江省产业链发展；二是以块状特色产业为基础，沿产业链上下游持续发力，变块状特色产业为链状产业联动，形成了特色产业循环发展、永续前进。

当链长制在浙江风生水起，其他各省市开始由观望转为跟进。2019年底，广西壮族自治区和内蒙古自治区部分市（盟）率先效仿。自此，拉开了链长制登上全国舞台的序幕。

[①] 资料来源：《产业集群之后，“链长制”如何助力区域时尚升级？》，https://new.qq.com/rain/a/20220301A01UTZ00。

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2.“新忧”:市场调节失灵

“外患”未解,“新忧”又至。2020年,新冠疫情在世界范围内的暴发对我国扎实推进产业链供应链稳定工作产生重大影响。在疫情突袭初期,全国各地封锁隔离,全面停工停产,产业链处于停摆状态。随着防疫抗疫进程有了阶段性成果,复工复产迫在眉睫,产业链运行却受劳动力短缺和物流堵塞的限制,面临“无米下锅”的尴尬情况。“缺一个零部件,停一条生产线”[②],产业链环环相扣,一个环节阻滞,就会导致产业链上跨区域企业难以协同,出现市场失灵。

当国内抗疫防线稳扎稳打,取得决定性胜利时,新冠疫情仍在全球蔓延。不同国家的具体国情和政策制度不同,导致疫情的蔓延程度及应对方法存在差异,势必间接影响我国企业的复工复产复销活动,进而导致各个产业链出现“痛点”和“断点”,难以形成自发连续的节奏。而外需疲软和断点危机使得全球产业链受到“长鞭效应”冲击,需求波动逆产业链而上并逐级放大,严重影响我国产业链的正常循环。此外,疫情冲击造成的国际物流堵塞会破坏及时交货系统的基础。出于防患于未然的考虑,跨国公司倾向于始终保持一定的生产剩余,并在国内市场和邻近国内市场的地区进行生产资料配置。跨国产业链开始内向化、本土化发展,致使经济全球化水平倒退,全球产业链和供应链可能会发生大面积的、普遍性的脱钩与断裂(刘志彪、孔令池,2021)。

“一荣俱荣,一损俱损”。在疫情肆虐全球的背景下,不仅难以实现市场资源最优配置,引发市场失灵,还加剧了逆全球化趋势,进一步推动我国产业链本土化发展。亟须政府通过产业政策引导产业链协同发展,弥补市场失灵,增强产业链韧性,竖起牢固的产业链安全墙。由此可以看出,链长制作为一种新制度供给的原生力量不仅来源于国际形势的变化,新冠的侵袭成为全国各地加速链长制建设的另一重要契机,链长制在全国范围内迅速扩散。

2020年,山东省、陕西省、河北省、江西省等20个省、168个地级市相继推行链长制。2021年,商务部印发《关于进一步推进国家级经开区创新提升 更好发挥开放平台作用的通知》,开始鼓励各地区的国家级经开区推行链长制,由此扩散至全国30个省(自治区、直辖市)。为何链长制能够在短短两年内迅速扩散至全国?一方面,得益于河长制和林长制成功的实践经验,缩短了链长制“摸着石头过河”的探索期,更易于推广和扩散;另一方面,链长制在湖南、浙江等省份的先行成功实践,证明了其既能够通过“领导挂帅”,统筹各部门、各地区的资源以应对市场失灵,又能够通过政企协同增强产业链韧性,防范重大风险。

总体而言,在扩散阶段,从链长制工作目标和顶层设计来看,其核心主题由原来的“提升产业链竞争力”转变为“把握产业链自主可控、维护产业链安全稳定”,开始强调效率与安全并行,具体工作机制也开始真正吸取和展现“领导挂帅、高位协调”这一中国特色问题解决机制的精髓。

[②] 资料来源:《20多省份推“链长制”:避免缺一个零件导致停一条生产线》,https://new.qq.com/rain/a/20220301A01UTZ00。

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（三）发展阶段（2021—2022年）：效率、安全、绿色低碳并行，多元化产业携手并进

追求经济效益目标的粗放式发展模式使我国生态环境问题日益严峻，二氧化碳排放量连续多年居于全球第一（范爱军等，2021）。为缓解生态环境问题带来的压力，我国迈入经济高质量、可持续发展阶段，将生态文明建设上升为国家战略，坚持贯彻绿水青山就是金山银山的理念，努力推动实现“双碳”目标。在“双碳”目标倒逼经济发展模式转型下，无论是新兴产业链还是传统产业链都要实现绿色低碳化发展。以链长制推动绿色低碳发展是当前产业链转型升级的题中之义。一方面，绿色低碳理念开始深入人心，绿色低碳产品和服务的市场需求增加带动了产业绿色低碳转型，这是链长制开始强调绿色低碳的原生力量；另一方面，市场机制在调节产业链主体行为过程中，由于外部性、信息不对称等问题出现一定的滞后性和“市场失灵”，加强生态环境保护和绿色低碳发展方面的制度供给尤为迫切。

浙江省作为最早一批布局链长制的省份，一直奉行处理好产业链发展底线与目标的关系，其链长制处处体现着绿色低碳理念。首先，浙江省链长制坚持经济生态化、生态经济化，更好地护绿管绿，更好地用绿活绿，努力打造绿色原创产业技术策源地，推进绿色低碳科技研发应用。其次，部分链长制试点单位正积极探索制造业等高能耗产业的绿色发展模式，推进产业链节能减排，鼓励发展清洁能源产业。[③]

在发展阶段，链长制作为一种地方政策制度创新，其推广是政策可复制性的检验过程，也是政策设计与执行在更广范围内的调整过程（王班班等，2020）。在发展过程中，核心主题由原来的“提升产业链竞争力”转变为“把握产业链自主可控、维护产业链安全稳定、推动绿色低碳转型”，开始强调效率、安全与绿色低碳并行。各地围绕“N个一”机制、“N张清单”、“挂图作战”等，结合其产业特征，因地制宜开展链长制实践，呈现出“百花齐放”的特点。对于各地纳入链长制的产业链类型而言，逐渐由开始侧重于工业制造业不断扩张至农业、新兴绿色产业、能源产业、人工智能产业等多元化产业携手并进。

（四）成熟阶段（2023年—）：有为“链长”与有效市场的有机统一

虽然链长制已经在国内进行了普遍复制和广泛推广，但随着外部环境的不断变化，除了地方保护主义抬头和生搬硬套链长制模式的潜在风险，其在各地实践、发展和推行过程中很容易陷入“全能政府”陷阱。一般而言，链长与链主功能可以看作是政府和市场关系，二者之间的有效匹配是产业链良性运转的重要基础（林淑君、倪红福，2022）。然而，在各地链长制的实践中，由于在产业政策上政府与市场的边界不够明晰，政府可能会忽视市场发展规律，代替链主企业深度参与市场活

③ 王琪：《34家开发区上榜!浙江“链长制”结硕果》，《国际商报》2022年1月25日，第7版。

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动，抑或地方政府盲目追求产业链绿色低碳的政绩目标，通过行政命令的方式给予企业过度的资源支持、政策补贴等，出现“拔苗助长”的现象（张贵，2021）。

链长制不应是一个终点，而要成为一个开始。那么，链长制如何以不变应万变，演变为真正既能适应变化，又能促进产业发展的制度？新结构经济学理论给出了较为合适的学理依据。链长制要从特殊时期的政府性举措演变为完善化、长期性和可持续性的制度建设，必然要遵循“有为政府是市场有效的前提，有效市场是政府有为的归依”的基本逻辑，链长是否“有为”在其中起到关键性的作用[④]。

基于此，本文认为，在成熟阶段，链长制应立足于产业链打造的现实瓶颈，明确“链长”的职能边界，避免政府作用的无限放大和延伸，使得产业链在有为“链长”的高位引导下，迈向基于效率、安全和绿色低碳并行的产业链转型升级之路。

纵观链长制的演化历程，其演化动因从强制性因素引发到诱致性因素诱发，再到强制性、诱致性因素共同引导，其阶段性特征也从强调效率为先转变为强调效率与安全并行，最后演变为强调效率、安全、绿色低碳并行。

二、绿色低碳农业产业链的由来、内涵与特征

（一）由来

从我国农业的发展阶段来看，农业1.0时期，传统农业依靠手工劳动和种植经验；农业2.0时期，工业化改造使得传统农业发展初现产业链雏形，以效率为主要生产目标；农业3.0时期，农业与第三产业的结合使得农业产业链不断延长、拓展；农业4.0时期，农业绿色化成为其重点发展方向之一（温铁军等，2021）。在国际社会由“以农业促发展”到“以农业绿化经济”的转变下，以绿色发展引领乡村振兴不仅是推动生态文明建设、实现“双碳”目标的必然要求，也是当前和未来我国农业农村工作的重心（金明华、刘晴，2019）。然而，当农业各项改革进入深水期，再也无法“一招鲜吃遍天”，必须从内生动力出发，形成一种可持续的机制，这样的绿色低碳才是有价值的，也是可复制、可推广的。具体而言，不能就绿色抓绿色，就低碳讲低碳，而是要放开格局，让绿色低碳贯穿农业产业链发展始终，成为农业产业链鲜明底色，从而真正实现绿水青山向金山银山的转换[⑤]。因此，在农业4.0时期农业绿色发展需要从推动农业产业链绿色低碳转型上发力。

值得注意的是，我国农业发展的演进方向与链长制从“效率为先”迈向“效率、安全和绿色低碳并行”的发展趋势相吻合。当前我国正处于百年变局时期，全球产业链分工与合作逐渐以产业链安

[④] 资料来源：《扎实推动五中全会精神落地落实》，https://www.ddgx.cn/show/40909.html。
[⑤] 资料来源：《构建农牧业绿色发展的内生动力》，http://qh.people.com.cn/GB/n2/2020/0112/c182775—33709320.html。

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全为基本逻辑(盛朝迅,2022)。我国要打造绿色低碳农业产业链,本质是在提升农业产业链效率的基础上,增强农业产业链自主可控性、韧性和可持续性,构建效率、安全与绿色低碳并行的绿色低碳农业产业链长效机制。在此基础上,2021年5月,农业农村部印发《关于加快农业全产业链培育发展的指导意见》,适时提出要开展农业全产业链链长制试点,同时强调要实现全产业链的绿色低碳化发展。这是我国政府研判加快培育发展农业全产业链需求,从实现保供固安全、振兴畅循环出发,以链长制为抓手,赋能农业产业链绿色低碳转型,进而推动乡村振兴和"双碳"目标的实现。

目前,辽宁、内蒙古、江西、广东、安徽、浙江、湖北、海南、青海、陕西、湖南等省(自治区)相继在农业领域开展链长制试点。同时,大部分地区在农业领域以绿色为底色开展链长制,如安徽省以链长制为抓手,聚焦"绿色食品"这一重点产业;西宁市以高原动植物精深加工产业链为方向实施链长制,进行"强链、补链、延链",打造独一无二的"超净区""高原绿色"品牌。

(二)内涵

农业产业链的概念最早由Hirschman(1958)提出,认为农业产业链是农产品从原料、加工、生产到销售的全部活动。经Mighell et al.(1963)、傅国华(1996)、王凯和韩纪琴(2002)、程华等(2019)学者补充和发展后,现大多认为农业产业链是一种由不同生产部门基于各自利益而构成的网络结构和运行机制。在此基础上,国内学者开始立足于我国国情,相继提出了低碳农业生态产业链和绿色农业产业链的概念。如齐振宏和王培成(2010)、杨启智(2012)认为,低碳农业生态产业链是由生态农业产供销活动相关的农户、合作社、企业等主体组成,依照自然生态系统中的生产、消费、分解和还原机制进行产业链接而形成的新型产业组织形式。柳一桥和肖小虹(2022)指出,绿色农业产业链是以现代科技和管理为支撑,以生态保护、效益提升、农产品安全为导向,通过分工协作将农业各环节紧密联结而形成的农业经营体系。基于上述研究,本文将绿色低碳农业产业链概括为以绿色为底色,将低碳循环理念贯穿农业研发、生产、加工、运输、销售、消费、服务全链条,且各环节和主体紧密关联、有效衔接、协同发展的农业有机整体。

(三)特征

除具有农业产业链的系统性、协调性和复杂性等特征外(黄艳等,2018),绿色低碳农业产业链还具有以下特征:第一,绿色性,绿色是绿色低碳农业产业链的底色。随着绿色低碳消费理念的推广,绿色低碳农业产业链不同环节主体会在比较利益驱动下积极践行绿色发展理念,实施绿色低碳行为,终端绿色食品需求和中间环节的绿色低碳需求均会呈现持续性增长态势。以市场需求为导向的绿色低碳农业产业链主体为增加利益往往会迎合绿色低碳理念,并将其贯穿于绿色低碳农业产业链各个环节。第二,正外部性,正外部性是绿色低碳农业产业链的本色。绿色低碳农业产业链将环境资源的外部性纳入内部效益,考虑的是长期生态效益而不是短期经济利益,有益于生态环境保护

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与资源利用，能够提供优质的公共生态产品，不仅具有典型的正外部性特征，还具有一定的代际传递性，可以放大农业生产的“收益外溢化”效应，形成持续性的良性影响。第三，循环性，循环性是绿色低碳农业产业链的特色。整个产业链条具有鲜明的循环利用设计，在绿色低碳农业产业链不同环节主体提高资源及能源利用效率的同时，环节间也将进行废弃物的集中处理和循环利用，从而提升碳效率。

（四）现状

2021年7月，农业农村部决定开展全国农业全产业链重点链和典型县建设工作，并指出绿色底色足是成为农业全产业链重点链和典型县的共性条件之一。同年11月，全国第一批农业全产业链重点链和典型县建设名单出炉，包括31个全产业链重点链和63个全产业链典型县。目前，31个全产业链重点链和63个全产业链典型县已取得初步成效。例如，辽宁盘锦稻谷全产业链重点链大力推广基于稻蟹共生的无公害生长环境，充分发挥盘锦大米绿色无公害的特色农产品资源优势，推进农产品品牌产权化、质量高端化、价值市场化，构建了产业链条全、绿色底色足、安全可控制、联农带农紧的绿色低碳农业全产业链，为乡村全面振兴和农业农村现代化提供了有力支撑。

2022年，部分地方政府也出台了开展省级现代农业全产业链典型县的相关政策。如陕西省为推进全省现代农业全产业链培育发展，树立了一批以绿色为底色的全产业链发展典型县。例如，洛川苹果的果畜循环产业链、宝鸡眉县猕猴桃的全国绿色食品原料标准化生产基地、鄠邑区（户县）葡萄的“三品一标”典范等，为助力乡村实现全面振兴奠定了坚实基础。由此可看出，我国绿色低碳农业产业链建设和发展正有序推进。然而，由于绿色低碳农业产业链建设刚刚起步，其打造过程仍面临一些现实困境。

三、打造绿色低碳农业产业链的现实困境

“外部竞争有力、主体协同有序、韧性持续增强、生态循环增值”是绿色低碳农业产业链的打造目标。然而，打造绿色低碳农业产业链并不是一蹴而就的，而是一个渐次升级的过程。迫切需要分析绿色低碳农业产业链面临的现实困境，从而使链长制立足于绿色低碳农业产业链的打造目标及实现瓶颈，明确“链长”的职能边界，厘清有为“链长”赋能绿色低碳农业产业链的具体路径。

（一）竞争力较弱

现阶段绿色低碳农业产业链现代化、规模化、标准化程度均较低，进而导致其竞争力较弱，难以实现“外部竞争有力”的打造目标。绿色低碳农业产业链现代化程度难以提升的关键在于创新力驱动不足（盛朝迅，2022）。创新具有外溢性，绿色低碳农业产业链各环节主体在协同创新的过程中

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可能会出现“搭便车”“敲竹杠”等市场失灵现象，进而导致创新供给不足，原创性、突破式创新难以为继。[6]此外，水肥一体化、沼气发酵、测土配方施肥等农业绿色低碳技术和农业废弃物肥料化、饲料化、能源化技术的研发、应用和推广还面临初始投入较大、技术应用规模不经济、技术成熟度不够等问题，甚至被束之高阁。

绿色低碳农业产业链要实现规模化的前提是拥有强大的资金基础和支持。目前，绿色低碳农业产业链面临吸资引资难、资金循环不畅等问题，不仅不能保证生产原料、技术、人才等资源的高效运转，而且难以为产业链创新提供充足的资金供给，导致产业链生产规模无法进一步扩大，持续运营发展难以为继。具体而言，一是绿色低碳农业作为新兴产业，从概念到行动，既是观念的根本转变，也是摸着石头过河，往往存在风险缓释能力不高的问题，收益回笼不稳定，难以吸引社会资金投入；二是地方农业经济通常依赖于土地和税收等普惠性政策的传统招商引资方式，但随着国内外局势愈发复杂，这种招商引资方式的优势在逐渐弱化；三是在传统农业金融机构中，大多数金融机构并没有启动绿色化改造，而农村地区银行绿色贷款等项目建设尚处于试点摸索阶段，且与农业产业发展紧密相关的鲜活资产贷款、作物资产贷款、设施设备抵押贷款、“三权”抵押贷款等产品较少；四是绿色信贷在绿色金融占比90%以上[7]，其他绿色金融产品如绿色债券、绿色保险则相对不足，导致我国农业绿色金融产品之间协同效应不强；五是农村存在大量闲置低效的存量资产，面临难以处置、盘活的困境，无法实现新旧资产的互促共存。

目前，我国正积极推行农业生产全产业链“品种培优、品质提升、品牌打造、标准化生产”的“新三品一标”。但在“新三品一标”的推行过程中，绿色低碳农业产业链面临诸多问题，导致其标准化程度较低。从全产业链标准体系来看，我国农产品标准化相对缺乏系统性，绿色低碳农业产业链的种源追溯、生产规范、品牌注册各个环节的标准化衔接存在缺口，出现生产端“优质卖不上优价”与消费端“优价买不到优质”并存的现象。具体而言，从种源追溯来看，绿色低碳农产品多为创新型农产品，种源面临假种子问题层出不穷、珍贵种质资源流失等问题，且难以追溯；从品质提升来看，关于部分绿色农产品的农药化肥的使用标准尚未统一界定，不能真正做到减量增效；从品牌注册来看，我国农业生产经营主体众多、品牌数量多且小杂乱，品牌假冒伪劣现象屡禁不止，严重缺乏全国和行业的规范性。

（二）协同度较低

绿色低碳农业产业链的有效运转离不开主体与主体之间、上下游之间联系的协同稳定，然而，绿色低碳农业产业链面临主体高度分散和上下游衔接较差的问题，导致其协同度较低。具体而言，从主体来看，农业生产经营主体高度分散，头部企业发育不完全，导致绿色低碳农业产业链组织化

[6] 田瑞颖：《创新链能否搭上“链长制”快车？》，《中国科学报》2021年9月22日，第3版。
[7] 数据来源：《我国绿色金融发展成效显著 绿色信贷规模居世界第一》，https://m.gmw.cn/baijia/2021—11/18/35318947.html。

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程度不高，难以实现“主体协同有序”的打造目标。从上下游联系来看，绿色低碳农业产业链不同环节主体获取信息的能力不同，容易造成信息不对称约束，导致绿色低碳农业产业链上下游衔接较差，协同度较低。比如分散化的小农户经济实力薄弱且社会资本匮乏，缺乏市场监管且难以获取有效的信息，通常在上下游市场交易中处于弱势地位（王卫卫、张应良，2021），利益易遭到侵害，进而导致企农协同失调，小农户无法真正地参与到绿色低碳农业产业链打造中，难以实现与现代农业发展的有机衔接（韩喜艳等，2020）；绿色低碳技术或产品推广不深入、宣传不到位，导致农户难以采纳，产研无法有效衔接。

（三）韧性不足

韧性持续增强是绿色低碳农业产业链高质量发展的保障。然而，由于绿色低碳农产品的绿色成本过高、冷链物流堵塞和绿色通道受阻，导致绿色低碳农业产业链脆弱性较高，面临韧性不足的困境。具体而言，在成本方面，绿色低碳农业产业链面临绿色成本问题，高昂的绿色成本增加了各环节主体的经济负担，从而在产品渠道和营销市场竞争中出现寻租、投机行为，“劣币驱逐良币”“优质不能优价”现象层出不穷。当绿色成本分担不均衡、不合理时也会加剧绿色低碳农业产业链企农协同失调。在物流方面，外界冲击造成的物流堵塞对绿色低碳农产品的销售和冷链运输产生不利影响，引发农产品库存短缺风险，进而影响绿色低碳农产品供给和价格；在绿色通道方面，贯穿全产业链的农业废弃物无害化处理和资源化利用通道受阻，存在废弃物利用率过低、缺乏有效的循环利用运营机制、区域统筹管理乏力等问题（张林秀等，2021）。

此外，如前所述，绿色低碳农业产业链创新力驱动不足，意味着其难以承受外来冲击和关键技术制约，抵抗能力与恢复能力较差，进而导致其脆弱性较高，韧性明显不足。

（四）生态增值乏力

生态循环增值是绿色低碳农业产业链转型升级和价值实现的终极目标。然而，由于绿色低碳农业产业链的收入单一化和绿色低碳产品消费意识的淡薄，导致其生态增值乏力。从收入角度来看，一是没有充分挖掘和利用绿色低碳农业的生活、生态和文化等功能，缺乏对绿色低碳农业产业链的有效横向拓展与延伸，受到收入单一化的制约。二是绿色低碳农业产业链的终端收益来源为绿色低碳农产品消费者，但目前绿色低碳农产品的消费市场仍旧低迷，一方面，消费者的绿色低碳消费意识较低，对于绿色低碳农产品的态度仍旧是“可买可不买”的游离状态；另一方面，绿色低碳农业产业链各环节主体绿色低碳意识仍旧较为浅薄，难以通过逐层需求拉动终端绿色低碳消费。

基于上述不难看出，绿色低碳农业产业链竞争力弱会使得产业链主体之间难以协同有序，进而造成产业链韧性不足，最终绿色低碳农业产业链生态增值乏力，难以实现“生态循环增值”的终级打造目标。

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四、链长制赋能绿色低碳农业产业链的具体路径

绿色低碳农业产业链的现实困境无法依靠市场自我调节来自行解决，亟须政府出面协调各方，通过链长制赋能以弥补市场失灵。然而，链长制赋能过程中易陷入全能政府陷阱，政府的有形之手很容易越过市场发展规律，代替产业链主体发挥其作用，甚至给予链条上部分主体很大优惠，导致拔苗助长。因此，只有关注农业产业链转型升级过程中政府与市场的关系变化，“链长”对症下药，因势利导解决市场难以解决的关键症结，才能构筑起有为政府的边界，真正实现有为“链长”对绿色低碳农业产业链的赋能。有为“链长”将遵循“外部竞争有力、主体协同有序、韧性持续增强、生态循环增值”的打造目标，针对打造绿色低碳农业产业链的现实困境，充分发挥其仲裁者、引导者、协调者和统筹者等角色功能，因势利导赋能绿色低碳农业产业链（如图1所示）。

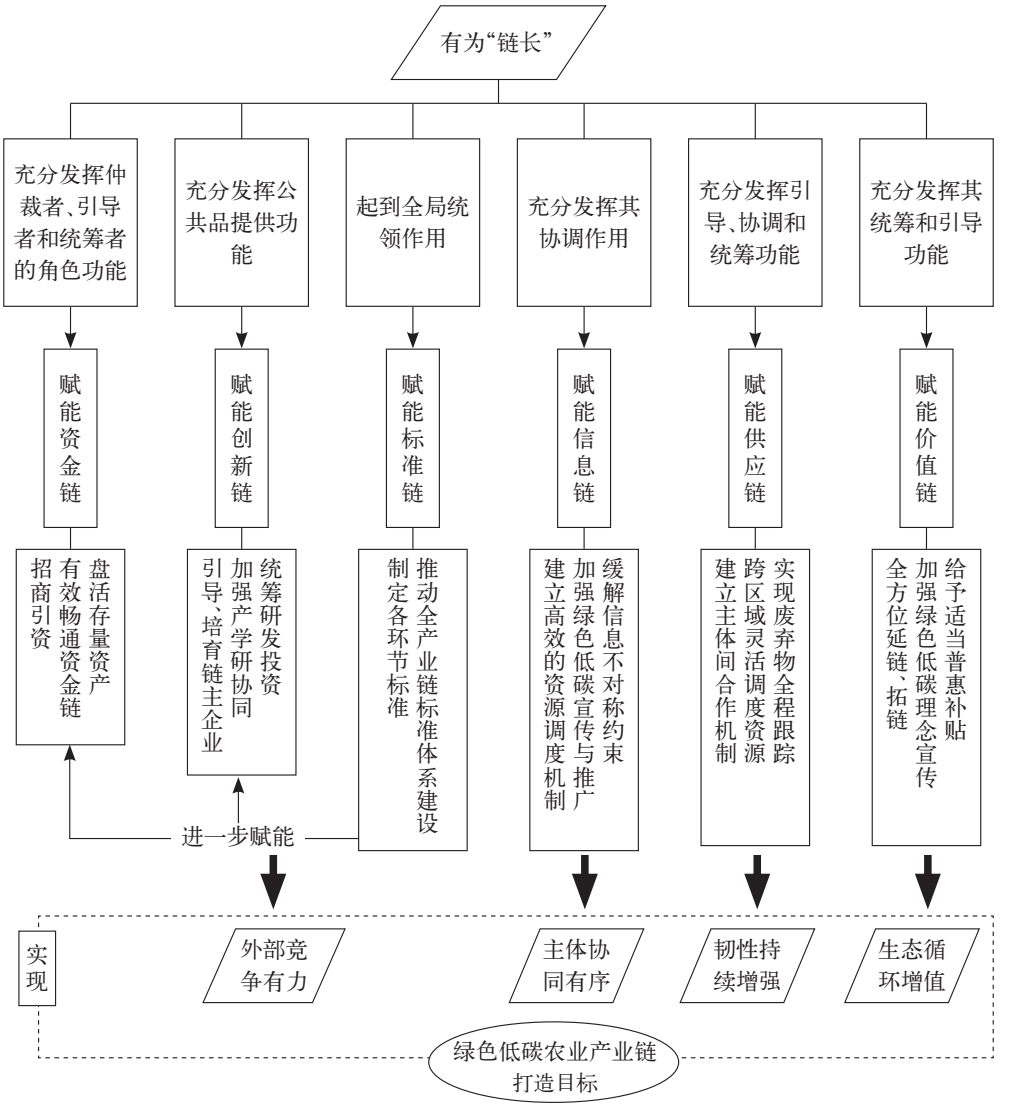

图1：有为“链长”赋能绿色低碳农业产业链的具体路径

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（一）赋能资金链、创新链和标准链，实现“外部竞争有力”

有为“链长”能够通过盘活资金链、强化创新链、建设标准链以实现“外部竞争有力”。

首先，有为“链长”能够充分发挥仲裁者、引导者和统筹者的角色功能，持续为绿色低碳农业产业链资金链注入活力（中国社会科学院工业经济研究所课题组、曲永义，2022）。一是有为“链长”能够通过招商引资破解资金“干涸”困境。一方面，有为“链长”的“眼光”更精更准，能够根据当地农业特色，制定产业链图谱，对绿色低碳农业产业链实施精准化“双招双引”，通过“链长”引导成立组内分工明确的招商小组，全面摸排当地企业和企业家的详细信息并建立信息库，将资金优势转化为资智两全的胜势。另一方面，有为“链长”的“眼界”更宽更广，能够瞄准产业链关键环节，以目标为导向统筹区域资源配置，跨区甚至跨国招商引资，实现区域间资金有效流动。二是有为“链长”能够有效畅通资金链。一方面，有为“链长”通常掌握更加充分的市场信息，能够引导传统农业金融服务机构设立农业绿色金融主线和专项，通过区域性农业数字金融平台引导线上涉农金融平台加强银企绿色融资对接，从而推出真正符合绿色低碳农业产业链主体需求的农业绿色金融产品，同时协调各个农业绿色金融产品之间的内容和功能互补，以盘活整个产业链资金流动。另一方面，有为“链长”能够高位统筹农业绿色金融标准体系，通过将与链内企业环境绩效相关的标准和指标纳入信贷流程和审核标准，不断深化对绿色低碳农业产业链主体的绿色金融服务，充分发挥市场性绿色低碳金融的作用，确保资金链在全产业链不间断地循环流动。三是有为“链长”能够通过统筹农业绿色低碳项目的承载空间，有效盘活农村闲置土地、低效不良资产等存量资产，形成存量资产和新增投资的良性循环。

其次，有为“链长”能够充分发挥其公共品提供功能，强化创新链，增强产业链有效竞争力。一是有为“链长”能够对链主企业进行引导和培育，加大链主企业的研发投入，提升其创新能力，并制定合理的助推政策以促进农业绿色低碳技术和农业废弃物循环利用技术开发、推广与应用。二是有为“链长”能够鼓励区域内不同绿色低碳农业产业链的共建互通，加强产学研协同，共同搭建研发创新平台以推动共性技术联盟，协同促进科研成果有效转化，实现绿色低碳农业技术开发和基础与应用研究融通发展。三是有为“链长”能够统筹地方金融机构和政府对绿色低碳农业研发的投资，可以优先设立共性技术研发基金，有助于攻破绿色低碳农业关键技术领域。

最后，有为“链长”能够起到全局统领作用，引导地方政府根据消费者市场对不同绿色低碳农产品的需求，制定绿色低碳农业产业链各环节标准，推动全产业链标准体系建设，进一步赋能资金链和创新链，实现产业链外部竞争有力。一是总“链长”通过统筹区域分“链长”，加快构建和完善种源追溯系统，促进种源信息追溯共享，防止优良种源资源的流失。二是有为“链长”能够带动地方农业部门对农药化肥的规范使用进行宣传和培训。三是有为“链长”能够引导链主企业注重良好口碑的传播，加强区域农产品品牌建设。

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（二）赋能信息链，实现“主体协同有序”

有为“链长”能够充分发挥其协调作用，在总链分链的有效递进的基础上，建立高效的资源调度机制，并充分利用新一代信息技术，打通绿色低碳农业产业链上的断点、痛点、堵点，实现主体协同有效。一是有为“链长”能够充分借助数字经济赋能效应，通过利用物联网、大数据、云计算和区块链等技术搭建信息共通的网络平台，加快绿色低碳农产品市场的建立，提高供给与需求的精准匹配和高效对接，带动绿色低碳农业产业链产供销、上下游、大中小企业协同发展，提升绿色低碳农业产业链要素聚合力。二是有为“链长”不仅能够借助数字赋能帮助小农户获得更多有效的市场信息，还能够加强绿色低碳技术的宣传与推广，增加绿色低碳技术的普及率。三是有为“链长”能够为农户提供使用网络平台的培训，拓宽其获取信息的渠道，提高其信息搜集能力，缓解信息不对称约束。

（三）赋能供应链，实现“韧性持续增强”

有为“链长”能够充分发挥引导、协调和统筹功能，助力供应链的稳定供给，增强绿色低碳农业产业链韧性。一是有为“链长”能够引导“链主”企业充分发挥头雁作用，以缓解绿色低碳农业产业链不同环节主体的矛盾，通过设立绿色成本分担和回购合同的方式，建立主体间成本共担、利益共享的合作机制，实现企农协同发展，弥补市场失灵。二是有为“链长”能够跨区域灵活调度资源，充分利用数字技术规划冷链物流网络，建立仓储资源平台，促进城乡、区域间冷链物流畅通，通过有效统筹物流分类规划，建立绿色低碳农业产业链的海空陆冷链物流渠道，打通运输堵点，保证调度及时，以便于处理冷链运输过程中的突发意外状况，促进供应链稳定供给。三是有为“链长”能够通过区块链技术实现对绿色低碳农业产业链产生的废弃物进行记录，监控废弃物无害化处理、资源化利用的每个流程，直到废弃物被安全妥当地处理为止，增强废弃物利用率，实现产业链韧性持续增强。

（四）赋能价值链，实现“生态循环增值”

有为“链长”能够充分发挥其统筹和引导功能，通过一系列奖惩措施和发展策略，使得绿色低碳理念实现由上到下、由里至外的链式渗透，实现生态循环增值。一是有为“链长”通过深入挖掘绿色低碳农业的数字、文化和生态等功能，全方位延链、拓链，推进农村一二三产业深度融合发展。二是有为“链长”不仅能够通过加强对绿色低碳理念的宣传引导消费者的消费理念向绿色低碳转型，还可以通过给予适当的普惠补贴刺激消费者进行绿色低碳农产品消费，最终从需求侧拉动农业产业链持续绿色低碳发展。

参考文献

[1] Hirschman, Abert O. 1958. *The Strategy of Economic Development*. New Heaven: Yale University Press.

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[2] Mighell, Ronald L., and Lawrence A. Jones. 1963. *Vertical Coordination in Agriculture*. U. S. Government Printing Office.

[3] Porter, M E. 1990. *The Competitive Advantage of Nations*. New York: Free Press.

[4] 程华、卢凤君、谢莉娇，2019，《农业产业链组织的内涵、演化与发展方向》，《农业经济问题》第12期。

[5] 范爱军、郑志强、马永健，2021，《贸易政策、全球价值链位置与中国二氧化碳排放》，《山东大学学报》（哲学社会科学版）第6期。

[6] 傅国华，1996，《运转农产品产业链　提高农业系统效益》，《中国农垦经济》第11期。

[7] 高杨、姚雪、白永秀、吴振磊，2022，《有为"链长"赋能绿色低碳农业产业链：内在机理与实现路径》，《经济学家》第12期。

[8] 韩喜艳、刘伟、高志峰，2020，《小农户参与农业全产业链的选择偏好及其异质性来源——基于选择实验法的分析》，《中国农村观察》第2期。

[9] 黄先海、宋学印，2021，《赋能型政府——新一代政府和市场关系的理论建构》，《管理世界》第11期。

[10] 黄艳、左瑞瑞、陈淑芬，2018，《我国农业产业链的影响因素、机制与成长途径》，《商业经济研究》第6期。

[11] 金明华、刘晴，2019，《"新零售"背景下农业产业链主体利益分配问题研究》，《学术交流》，第5期。

[12] 梁小军、胡多，2022，《共同富裕目标下相对贫困治理的制度逻辑》，《学习与实践》第7期。

[13] 林淑君、倪红福，2022，《中国式产业链链长制：理论内涵与实践意义》，《云南社会科学》第4期。

[14] 刘修岩，2009，《集聚经济与劳动生产率：基于中国城市面板数据的实证研究》，《数量经济技术经济研究》第7期。

[15] 刘志彪、孔令池，2021，《双循环格局下的链长制：地方主导型产业政策的新形态和功能探索》，《山东大学学报》（哲学社会科学版）第1期。

[16] 刘志彪、凌永辉2021，《论新发展格局下重塑新的产业链》，《经济纵横》第5期。

[17] 柳一桥、肖小虹，2022，《以绿色发展引领乡村振兴——民族山区绿色农业产业链的形成机理与演进路径》，《中南民族大学学报》（人文社会科学版）第1期。

[18] 齐振宏、王培成，2010，《博弈互动机理下的低碳农业生态产业链共生耦合机制研究》，《中国科技论坛》第11期。

[19] 盛朝迅，2022，《从产业政策到产业链政策："链时代"产业发展的战略选择》，《改革》第2期。

[20] 屠年松、龚凯翔，2022，《"引进来""走出去"的技术溢出对制造业价值链的效应研究——基于研发能力和产业集聚的门限回归检验》，《暨南学报》（哲学社会科学版）第7期。

[21] 王班班、莫琼辉、钱浩祺，2020，《地方环境政策创新的扩散模式与实施效果——基于河长制政策扩散的微观实证》，《中国工业经济》第8期。

[22] 王凯、韩纪琴，2002，《农业产业链管理初探》，《中国农村经济》第5期。

[23] 王卫卫、张应良，2021，《区域品牌赋能：小农户衔接现代农业的有效路径——基于四川省眉山市广济乡的案例调查》，《中州学刊》第5期。

[24] 温铁军、唐正花、刘亚慧，2021，《从农业1.0到农业4.0》，东方出版社。

[25] 杨启智，2012，《产业链视角下的低碳农业发展研究》，《学术论坛》第6期。

[26] 张贵，2021，《以"链长制"寻求构建新发展格局的着力点》，《人民论坛》第2期。

[27] 张林秀、白云丽、孙明星、徐湘博、加林，2021，《从系统科学视角探讨农业生产绿色转型》，《农业经济问题》第10期。

[28] 中国社会科学院工业经济研究所课题组、曲永义，2022，《产业链链长的理论内涵及其功能实现》，《中国工业经济》第7期。

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Evolution and Empowerment of China's Chain Chief System toward Green and Low-Carbon Agricultural Value Chains

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Abstract: *The chain chief system, an innovation in industrial institutions led by local governments, is a cornerstone in the transition of agricultural value chains from "efficiency first" to "equal emphasis on efficiency, security, and green and low-carbon development". In this paper, we review the origin of the chain chief system and its growing emphasis on the importance of capable chain chiefs. We identify the origin, implications and characteristics of green and low-carbon agricultural value chains and reveal the background of those chains. Green and low-carbon agricultural value chains should achieve "vigorous external competition, coordination between value chain stakeholders, increasing resilience, and value addition from an agribusiness ecosystem". Based on this goal, we identify gaps in the competitiveness, coordination, resilience and value addition of green and low-carbon agricultural value chains. Focusing on the importance of capable chain chiefs, we suggest ways for the chain chief system to assist the innovation chain, the capital chain, the standardization chain, the information chain, and the value chain of green and low-carbon agriculture.*

Keywords: *Chain chief system, green and low-carbon agricultural value chains, capable chain chiefs, agricultural transition and upgrade*

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Agricultural value chains are central to the implementation of China's strategy to revitalize the countryside and develop into an agricultural powerhouse. They are also the basis for the achievement of carbon peak and carbon neutrality. As such, the *14th Five-Year Plan for National Green Agriculture Development* has called for "cultivating green and low-carbon agricultural value chains". However, China's green and low-carbon agricultural value chains lack competitiveness, coordination, resilience, and value addition. These constraints cannot be circumvented only through regulation of the market. Instead, the government's intervention is crucial to correct market failure and assure effective market-based resource allocation (Huang and Song, 2019). An integrated innovation of China's institutional strength and market-based factor allocation, the chain chief system combines an effective market with a capable government (Gao et al., 2022). In this context, the Ministry of Agriculture and Rural Affairs released the *Guiding Opinions for Expediting the Development of Agricultural Value Chains*, which called for the implementation of a pilot program of the agricultural chain chief system for green and

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low-carbon development throughout the value chains. The question is how does the chain chief system contribute to the growth and development of green and low-carbon agricultural value chains?

To answer this question, this paper discusses the four stages in the development of the chain chief system to identify its evolving trend and future direction. We provide an analysis of the origin, implications and characteristics of green and low-carbon agricultural value chains, as well as challenges to their actualization. An in-depth investigation has been carried out to identify specific ways chain chiefs can improve the green and low-carbon agricultural value chains.

This paper is intended to make the following contributions: First, it is intended to deepen the theoretical understanding of and research on the chain chief system by identifying its evolving trend and future direction. There are four stages in the development of the chain chief system: Inception, adoption, development and sophistication. Second, it presents a discussion of the origin, implications, characteristics and background of green and low-carbon agricultural value chains, and examines challenges to the actualization of "vigorous external competition, orderly coordination among stakeholders, increasing resilience, and value addition". How to achieve this goal is discussed in detail. Third, it suggests ways by which capable chain chiefs can improve green and low-carbon agricultural value chains in the innovation chain, the capital chain, the standardization chain, the information chain, the supply chain, and the value chain. Our findings and suggestions are of great relevance to practice and policymaking.

1. Formation of the Chain Chief System: Origin, Adoption, Development and Sophistication

According to institutional economics, the chain chief system is a transformation of the traditional industrial system in response to internal and external forces. It is a new method of industrial administration led by local governments to compensate for the inadequacies of market development and maintain the normal functioning of market mechanisms (Liu and Kong, 2021). Based on the existing bureaucratic organizational structure, the chain chief system has created a flat coordination mechanism to facilitate horizontal multisectoral coordination that breaks through the internal bureaucratic structure, reduces the costs and increases the administration coverage (Liang and Hu, 2022). This section explores the origin of the chain chief system that was a result of institutional transformation.

1.1 Inception Stage (2017-2018): Focus on Efficiency and Industrial Development

In the reform era since 1978, China has established development zones to attract foreign capital, technology and managerial experience, stimulating international industrial relocation, which has facilitated its rapid economic development (Sheng, 2022). According to the industry agglomeration theory, development zones lead reform and development, and create positive externalities for the region under economies of scale and learning effects (Liu, 2009). However, the pursuit of industrial efficiency and rapid development has resulted in development zones having a homogeneous industrial structure, with excessive industrial concentration (Tu and Gong, 2022).

In the context of limitations to the consumption of land and energy and fierce industrial competition, development zones are focal points for industrial convergence, coordination and synergy at a higher level. According to Porter's competitive advantage theory (Porter, 1990), a country must be able to integrate regional production factors such as labor, capital and land in order to turn them into competitive strengths. Under this rationale, the government should integrate and coordinate regional production factors by means of administrative decrees and laws and regulations in order to bring about institutional transformation. This is the role of chain chiefs.

At the end of 2017, the Changsha City government called upon local officials to "serve as industrial chain chiefs for development zones at the provincial level or above" in order to "propel high-quality

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economic development through industrial chain development."[1] This marked the first appearance of the term "chain chief" in an official document. In April 2018, Xiangtan City of Hunan Province initiated the chain chief system led by local governments to promote high-quality regional industrial development. Officials of the Hunan provincial government began to serve as chain chiefs. Their involvement was a catalyst for the chain chief system. Not only did the officials-turned chain chiefs help lower the cost of cross-sectoral and cross-regional consultation and cooperation, they also played a central role in coordinating production factors and developing synergic forces for various sectors and regions, cultivating high-quality regional industrial chains. Panjin City of Liaoning Province also launched the chain chief system to guide industrial development.

In the inception stage, with a priority on efficiency, the chain chief system was implemented in development zones to boost manufacturing competitiveness, smooth industrial transition and stimulate high-quality development. Senior officials were appointed to ensure the success of the chain chief system.

1.2 Adoption Stage (2019-2020): Rapid Permeation into Other Industries with Equal Emphasis on Efficiency and Security

1.2.1 External challenge: Contradiction between self-reliance and efficiency

Increasing backlash against globalization and escalating China-US trade frictions have interrupted and restrained industrial chains. Chinese companies, highly dependent on the US market, are faced with higher tariffs and export costs that may cause an industrial relocation. Falling foreign direct investment (FDI) in China's labor-intensive industries also trigger industrial and trade relocation, causing gaps throughout industrial chains. In addition, China's industrial chains are faced with external constraints. At the heart of the China-US trade conflict is the fight for the high ground of science and technology and top-notch professionals, in which the United States has imposed a technology export ban to curb China's high-tech development (Liu and Ling, 2021). The export ban has forced numerous Chinese firms to turn to domestic sources of constricted technologies.

No company is immune to the consequences of industrial chain disruptions. Security and stability have played a central role in China's efforts to reshape its industrial chains. However, efficiency may suffer in the quest for self-sufficiency. It is strategically important to investigate ways for China to take full advantage of its whole-nation system under the socialist market economy and leverage its strength of an ultra-large market to overcome disruptions, develop more competitive and resilient industrial chains, and achieve a balance between security and efficiency. In this context, the government should adopt a series of policies and promote institutional transformation to meet evolving international situations.

In August 2019, Zhejiang Province initiated the province-wide implementation of the chain chief system in response to the China-US trade conflict in fulfillment of the policy priority to "stabilize employment, finance, trade, foreign capital, domestic investment, and market expectations". Party and government officials in the cities, counties or districts of development zones were appointed as "chain chiefs" to facilitate coordination. The chain chief system proved to be a great success in Zhejiang Province, where the system was a catalyst for industrial chain development in the development zones as it played a pivotal role in the coordination of upstream and downstream industrial sectors to bring about synergy.

The success of the chain chief system in Zhejiang encouraged other provinces and municipalities to emulate them. Among these provincial-level regions and cities were some prefectures and leagues of Guangxi and Inner Mongolia, which took similar steps at the end of 2019. This marked the beginning of the nationwide implementation of the chain chief system.

[1] Source: After the industrial cluster, how does the "chain chief system" help the regional fashion upgrade? https://new.qq.com/rain/a/20220301A01UTZ00.

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1.2.2 Domestic concerns: Market failures

The COVID-19 pandemic in 2020 caused a severe setback for China's supply chains. Industrial operations ceased during the initial phase of nationwide lockdowns. Despite initial triumph in the containment of the pandemic, the resumption of factory operations was hampered by labor shortages and logistical complications. "The absence of a single component calls for the shutdown of the entire production line."[2] Every operation within an industrial chain is interconnected. Market failure may ensue when any process within an industrial chain is disrupted, as this can have cascading effects on downstream businesses.

As COVID-19 spread across the world, Chinese companies faced severe challenges of COVID-related supply chain disruptions. The slump in external demand and logistical issues had a negative effect on global supply chains. Wild demand volatility had repercussions in upstream industries, seriously disrupting China's industrial chain circulation. In addition, international logistical disruptions during the COVID-19 pandemic shook the foundation of just-in-time delivery systems. Uncertainties compelled multinational companies to maintain a certain level of surplus production and distribute this surplus in their domestic market and neighboring regions. The localization of cross-border supply chains mirrors a decline in the level of economic globalization, which can cause widespread global supply chain decoupling and rupture (Liu and Kong, 2021).

The COVID-19 pandemic, in addition to crippling market-based resource allocation, worsened the backlash against globalization and increased the localization of China's supply chains. In order to improve the resilience and security of the industrial chain, it is necessary for the government to guide the coordination of the industrial chain and ensure security through the implementation of industrial policy. The chain chief system, a new institutional arrangement to cope with the changing international situation, became widely adopted across China during the COVID-19 pandemic.

In 2020, 168 prefecture-level cities in 20 provinces, including Shandong, Shaanxi, Hebei and Jiangxi, implemented the chain chief system. In a circular released in 2021, the Ministry of Commerce vowed to encourage implementation of the chain chief system in state-level economic and technological development zones. As a result, the chain chief system became implemented in 30 provinces, municipalities and autonomous regions across China. Two factors contributed greatly to the rapid implementation of the chain chief system across the country: The implementation of the river chief system and the forest chief system shortened the explorative stage of the chain chief system and chain chiefs proved to be capable of coordinating resources across sectors and regions to cope with market failures, increase the resilience of supply chains, and avoid significant risks in provinces such as Hunan and Zhejiang.

The chain chief system shifted priority from "industrial competitiveness" to "industrial chain self-reliance, security and stability", placing equal emphasis on efficiency and security. As a problem-solving mechanism with Chinese characteristics, the chain chief system is characterized by the appointment of high-ranking officials to be responsible for supply chain coordination.

1.3 Development Stage (2021-2022): Emphasis on Efficiency, Security, and Green and Low-Carbon Development

China's recent pattern of GDP-centric development has resulted in worsening environmental problems, making the country the largest CO_2 emitter in the world for many consecutive years (Fan et al., 2021). To alleviate these environmental problems, the Chinese government has unveiled a new stage of high-quality and sustainable economic development. It has made the achievement of ecological civilization into a national strategy, implementing the concept that "lucid waters and lush mountains are

[2] Source: "More than 20 provinces have promoted the 'chain chief system': to avoid the absence of a single component calls for the shutdown of the entire production line", https://baijiahao.baidu.com/s?id=1700995003697741973&wfr=spider&for=pc.

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invaluable assets", and committing to the achievement of carbon peak and carbon neutrality goals. This requires both emerging and traditional industries to embrace green and low-carbon development amid the transformation of the economic development mode. Green and low-carbon development under the guidance of the chain chief system is essential to China's industrial transformation and upgrade. The desirability of green and low-carbon development has become a firmly established concept. Increasing market demand for green goods and services has turbocharged the green movement, prompting the chain chief system to prioritize green and low-carbon development. However, market mechanisms are subject to a lag effect and occasional market failures in regulating the behaviors of supply chain stakeholders due to externalities and information asymmetry. Hence, for environmental protection and eco-friendly development, it is important to increase the institutional supply.

Zhejiang Province was the first to implement the chain chief system to promote industrial chain security and development under the rationale of green and low-carbon transition. In Zhejiang Province, the chain chief system is designed to foster green industries and technologies and facilitate the R&D and application of green and low-carbon technologies. Pilot projects have been undertaken to explore green development modes for manufacturing and other energy-intensive industries, conserve energy, reduce carbon emissions, and develop the clean energy industry.[3]

In the development stage, policy adjustment was necessary to ensure the implementation of the chain chief system on a broader scale (Wang et al., 2020). In this implementation process, priority was shifted from "industrial chain competitiveness" to "industrial chain self-reliance, security, stability, and green and low-carbon transition" with an equal emphasis on efficiency, security and green and low-carbon development.

Following the identification of key stakeholders, local governments implemented the chain chief system according to local conditions and priorities. The scope of the implementation was expanded from manufacturing to agriculture, emerging green industries, energy, and artificial intelligence (AI).

1.4 Sophistication Stage (since 2023): Capable Chain Chiefs plus an Effective Market

During its implementation nationwide, the chain chief system is being confronted with challenges from an evolving external environment. In some localities, protectionism is on the rise; in others, the chain chief system is implemented with little consideration of local conditions, which could be risky. In implementing the chain chief system, local governments may easily fall into the trap of an "omnipotent government". Generally speaking, the relationship between chain chiefs and chain owners is comparable to a government-market relationship, and effective government-market coordination undergirds the well-functioning of industrial chains (Lin and Ni, 2022). As a result of the vague boundary between the government and the market, however, it is tempting for the government to supplant supply chain owners and act as a market participant. Some local governments pick winners by flooding certain businesses with resources and policy allowances, setting unrealistic green and low-carbon targets (Zhang, 2021).

The chain chief system should be a beginning and not an endpoint. The question is how can the chain chief system keep up with the times while advancing industrial development? New structural economic theories provide justification for the above question. In order for the chain chief system to evolve from a government initiative during special times into a system of complete, long-term and sustainable institutional development, it must follow the rationale that "a capable government is the premise for an effective market, and an effective market is the foundation of a well-functioning government."[4] Capable chain chiefs play a pivotal role in achieving this goal.

It is necessary to define the functional boundary of chain chiefs in view of the constraints on

[3] Wang Qi: "34 Development Zones on the List! Zhejiang 'Chain Chief System' Bearing Fruit", *International Business Daily*, January 25, 2022.
[4] Source: "We made solid efforts to implement the principles of the Fifth Plenary Session", https://www.ddgx.cn/show/40909.html.

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industrial chain development in order to avoid the enlargement of the role of the government and promote efficient, safe, and eco-friendly industrial transformation and upgrade.

The chain chief system, initiated under government mandate, became widely accepted through the involvement of market forces, and, more recently, became impelled by a combination of government mandates and market forces. Initially intended to promote efficiency, the chain chief system subsequently gave equal priority to security and more recently, green and low-carbon development.

2. Green and Low-Carbon Agricultural Industrial Chain: Origin, Connotations and Characteristics

2.1 Origin

In the Agriculture 1.0 era, traditional agriculture relied on manual labor and farming experience; in the Agriculture 2.0 era, agricultural value chains took form to increase efficiency through the application of industrial technology; in the Agriculture 3.0 era, the integration of agriculture and the tertiary industry extended the agricultural industrial chains; in the Agriculture 4.0 era, green agriculture has become a key priority (Wen et al., 2021). In the international community, the role of agriculture has shifted from economic development to sustainability. In this context, the revitalization of China's countryside must follow the path of green development in order to achieve the goal of ecological civilization and carbon peak and carbon capture, which are the priorities of the Chinese government (Jin and Liu, 2019). With agricultural reforms entering uncharted waters, it is essential to develop a sustainable mechanism driven by endogenous motivations. Only in this way will green and low-carbon development be meaningful and replicable. Instead of isolated concepts, green and low-carbon development should be reflected in each process of development of the agricultural value chains in order to turn green mountains into gold mountains[5]. In the Agriculture 4.0 era, green agricultural development should focus on the green and low-carbon transformation of agricultural production chains.

The shift in priority of the chain chief system from prioritizing efficiency to placing an equal emphasis on efficiency, security and eco-friendliness coincides with the evolving direction of China's agricultural development. Faced with turbulent changes unseen in a century, industrial security has become the top priority of the division of labor and cooperation of the global industrial chain (Sheng, 2022). China aims to create green and low-carbon agricultural value chains that are self-reliant, resilient and sustainable, and develop long-term mechanisms for efficient, secure and sustainable agriculture. In May 2021, based on the decision of the Chinese government to develop secure and efficient agricultural value chains, promote green and low-carbon development, and achieve countryside revitalization and carbon peak and carbon neutrality goals, the Ministry of Agriculture and Rural Affairs released the *Guidelines for Accelerating the Development of Agricultural Whole Supply Chains*, calling for piloting the chain chief system in the development of green and low-carbon agricultural value chains.

The chain chief system has been implemented in the agricultural sector in provinces and autonomous regions such as Liaoning, Inner Mongolia, Jiangxi, Guangdong, Anhui, Zhejiang, Hubei, Hainan, Qinghai, Shaanxi, and Hunan. Most of these regions have implemented the chain chief system for green agriculture. Anhui Province has focused on the green food industry in implementing the chain chief system. Situated in the northeastern part of the Qinghai-Xizang Plateau, Xining City has implemented the chain chief system to promote intensive agricultural processing, enhance, complement and extend agricultural value chains, and develop unique green agricultural products based on the pristine fauna and flora on the plateau.

[5] Source: "Fostering the endogenous dynamism of green agricultural and livestock industries", http://qh.people.com.cn/GB/n2/2020/0112/c182775-33709320.html.

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2.2 Connotation

Albert O. Hirschman introduced the notion of agricultural value chains in 1958; they encompass the entire range of agricultural operations, including cultivation, processing, production, and marketing. Following the contributions of Mighell et al. (1963), Fu (1996), Wang and Han (2002), and Cheng et al. (2019), agricultural value chains have become widely recognized as being a network structure and operational mechanism dedicated to enhancing the benefit to various different economic sectors. Expanding on this, Chinese scholars introduced the concept of green and low-carbon agricultural value chains. Qi and Wang (2010) and Yang (2012) consider that low-carbon agricultural value chains represent an innovative model of industrial organization in which farmer households, cooperatives, and businesses collaborate to form value chains like the production, consumption, decomposition, and restoration processes in the natural ecosystem. Green agricultural value chains, as identified by Liu and Xiao (2022), form a system of operation in the agricultural sector that incorporates cutting-edge technology and management principles that prioritize ecological preservation, efficiency enhancement, and agricultural product safety. Green and low-carbon agriculture follow sustainable agricultural practices that incorporate circular economy and low-carbon economy principles into their interconnected and coordinated agribusiness links, including research and development, production, processing, transportation, marketing, consumption, and services.

2.3 Characteristics

Green and low-carbon agricultural value chains show the following traits, in addition to being systematic, coordinated, and complex (Huang et al., 2018): First, green and low-carbon agriculture's eco-friendliness makes it unique. Due to the growing public awareness of the benefits of green and low-carbon consumption it makes sense for agribusinesses to actively practice green development and encourage green and low-carbon behaviors. Second, positive externalities are generated from low-carbon and green agriculture value chains, which prioritize long-term ecological benefits over immediate economic gain. Not only are positive externalities created by resource conservation, environmental protection, and the provision of environmental public goods, but these positive externalities can also be passed down to future generations, resulting in agricultural production having long-lasting positive spillover effects. Third, the circular economy typifies low-carbon and eco-friendly agricultural value chains. Circular design has been employed by green and low-carbon agricultural value chains to boost energy and resource efficiency, encourage centralized waste treatment and recycling, and make the carbon footprint smaller.

2.4 Current Status

In July 2021, the Ministry of Agriculture and Rural Affairs initiated a national campaign to encourage the creation of agricultural value chains in demonstration counties. The current practice of green agriculture was one of the criteria used in choosing demonstration counties. The first wave of agricultural value chains and demonstration counties, which was comprised of 63 demonstration counties and 31 supply chains, were announced in November of that same year. Currently, 31 agricultural value chains in 63 demonstration counties are in the initial phase of development. One such is the agricultural value chain of rice-crab coculture in Liaoning Province. For customers prepared to pay more for better quality agricultural products, green farming has emerged as a selling point. Modern agriculture and revitalization of the countryside are undergirded by the creation of comprehensive, self-sustaining green agricultural value chains.

In 2022, some local governments named select provincial demonstration counties for modern agricultural value chains. Among these, Shaanxi Province nominated several demonstration counties for green agricultural chains, including fruit-livestock coculture for apple farms in Luochuan, a national standardized green food production center for kiwi fruit in Meixian County, Baoji, and green and organic food and agricultural geolabel for grape farming in Huxian County. These programs opened the road for

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all-round revitalization of the countryside. Despite making progress, China's development of green and low-carbon agricultural value chains faces several challenges.

3. Challenges to Creating Green and Low-Carbon Agricultural Value Chains

Developing green and low-carbon agricultural value chains that are characterized by external competition, coordination among stakeholders, resilience, and value addition is the ultimate goal. The creation of green and low-carbon agricultural value chain is a cumulative process and cannot be accomplished instantaneously. It includes exploring the challenges and identifying solutions gleaned from the chain chief system, as well as defining the functional boundaries of chain chiefs and identifying paths by which chain chiefs can support green and low-carbon agricultural value chains.

3.1 Low Competitiveness

The present lack of competitiveness in green and low-carbon agricultural value chains is primarily due to their relatively low levels of modernization, small economies of scale, and lack of standardization. The adoption of cutting-edge technology in the establishment of green and low-carbon agricultural value chains is thwarted by a lack of ingenuity (Sheng, 2022). Under the effect of innovation spillovers, various entities of green and low-carbon agricultural value chains may engage in free riding, extortion and other forms of market failure during the process of collaborative innovation[6], leading to both an undersupply of innovation and unsustainable innovation. Significant upfront investment is necessary to develop and implement green and low-carbon agricultural technologies such as fertilizer and water integration, biogas fermentation, soil testing and formulation, and the use of farm wastes as fertilizer, feedstock, and energy. The challenges of diseconomies of scale and inadequate technological sophistication impede the widespread adoption of these technologies.

Financial support is essential for green and low-carbon agricultural value chains to achieve economies of scale. The lack of capital has stymied innovation and prevented supply chain growth by blocking the flow of feedstock, technology and talent. Green and low-carbon agriculture has the potential to transform traditional concepts and practices. However, it presents risks and unstable returns that discourage private investors. With increasing complexities in domestic and international situations, it has become less advantageous for local governments to rely on traditional policies such as using land and tax credits to attract investment. In the financial sector, most traditional agricultural financial institutions have yet to embrace the transformation of traditional agricultural practices into green ones. In the countryside, projects such as green loans remain in the pilot stage and there is a limited supply of agriculture-related financial products such as mortgage loans for agricultural produce, livestock, equipment, and land, forest and property rights. While green credit accounts for over 90% of green finance[7], other green financial products such as green bonds and green insurance are in short supply, limiting the synergy between green agricultural financial products. A large stock of assets lays idle in the countryside and is unavailable for disposal and transaction.

China has been making great efforts to nurture superior species, improve quality, develop new products, and encourage standardized production. The current degree of standardization in green and low-carbon agricultural value chains is undesirable for a number of reasons. When viewed through the lens of the entire agricultural value chains, China's agricultural standardization appears to be fragmented rather than systematic. There are gaps in the standardization of seed tracing, production techniques, brand registration, and other processes of agricultural value chains. Selling high-quality goods for a premium price is challenging, and so is finding such goods for discerning consumers. For the majority of green and low-carbon agricultural products, tracing seeds is a challenging task due to the proliferation of

[6] Tian Ruiying: "Innovation Chain Can Catch the 'Chain Chief System' Express Train?" *Chinese Journal of Science*, September 22, 2021.
[7] Source: "China ranks first in the world for green credit issuance", https://m.gmw.cn/baijia/2021-11/18/35318947.html.

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counterfeit seeds and the depletion of valuable seed resources. The absence of standardized procedures related to the application of chemical fertilizers and pesticides in eco-friendly agricultural products hinders efforts to enhance quality by increasing efficiency and reducing chemical residues. With regard to brand registration, the agricultural market in China is teeming with numerous small agribusinesses, some of which engage in the production and distribution of counterfeit goods.

3.2 Lack of Coordination

Green and low-carbon agricultural value chains cannot function effectively without coordination between upstream and downstream supply chain entities. The problem is that those entities are fragmented and lack coordination. The absence of dominant enterprises has led to green and low-carbon agricultural value chains having poor organization. With asymmetric access to information, upstream and downstream entities have poor coordination with each other. Fragmented smallholders, in particular, have modest means and few social connections. Without market supervision and access to information, they have little bargaining power (Wang and Zhang, 2021). In the distorted relationship between agribusinesses and farmers, smallholders cannot take an active part in the creation of green and low-carbon agricultural value chains (Han et al., 2020). In addition, inadequate public communication creates barriers to the adoption of R&D, resulting in the poor reception of green and low-carbon technologies and products by farmers.

3.3 Poor Resilience of Green and Low-Carbon Agricultural Value Chains

Resilience is a key aspect of the high-quality development of green and low-carbon agricultural value chains, whose current fragility stems from the high cost of eco-friendly products, cold-chain logistics issues, and lack of access to toll-free transportation. Rent-seeking and speculative behaviors have emerged in distribution channels and market competition as a result of exorbitant green cost, giving rise to instances of "bad money driving out good money". Some consumers are reluctant to pay a premium for green food. Partnership between agribusinesses and farmers becomes distorted if the green cost is shared in an uneven and unreasonable manner. External logistical shocks disrupt the marketing and cold-chain transportation of green and low-carbon agricultural products. The resulting shortage of inventory has ramifications on product supply and price. Agricultural wastes are not eligible for toll-free transportation for harmless treatment and recycling. Only a small proportion of agricultural waste is recycled due to the absence of effective recycling mechanisms and regional coordination (Zhang et al., 2021).

Lack of ingenuity makes green and low-carbon agricultural value chains susceptible to external shocks and technology constraints, making them fragile and less resilient.

3.4 Limited Value Addition

The ultimate goal of value realization and the development of green and low-carbon agricultural value chains is value added. Value addition from eco-friendly agricultural products has been hampered, however, by limited revenue streams and inadequate consumer awareness. Further exploration of the recreational, ecological, and cultural benefits associated with green and low-carbon agriculture is necessary in order to extend agricultural chains and generate additional revenue. Possible explanations for the lack of consumer demand for green and low-carbon agricultural products include that consumer interest in purchasing ecological and low-carbon agricultural products is low and the promotion of green and low-carbon consumption is not adequately supported by the diverse stakeholders in the green and low-carbon agricultural value chains.

As can be seen from the above, value addition from green and low-carbon agricultural value chains is hampered by uncompetitiveness, the absence of coordination between stakeholders and insufficient chain resilience. These challenges have made achieving the ultimate goal of ecological circulation and value addition elusive.

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4. Pathways by Which the Chain Chief System Can Support Development of the Green and Low-Carbon Agricultural Value Chains

Self-regulation of the market is not enough to resolve the challenges confronting green and low-carbon agricultural value chains. In order to compensate for market failures and facilitate coordination among stakeholders, the government must employ the chain chief system. However, the government's visible hand can fall prey to the entrapment of an omnipotent government if it provides incentives to supply chain entities in excess of what is required by the laws of market development. In the upgrading and transformation of agricultural value chains, the chain chief system should prioritize challenges that are beyond the scope of market-based mechanisms. By following this approach, the limits of a capable government that can support the chain chief system in advancing green and low-carbon agricultural value chains can be clearly defined. Supply chain chiefs assume the responsibilities of arbitrators, facilitators, and coordinators. It is their duty to provide guidance and support for the advancement of green and low-carbon agricultural value chains, as well as to address any challenges that may arise in order to enhance competition, coordination, resilience, and value addition (refer to Figure 1).

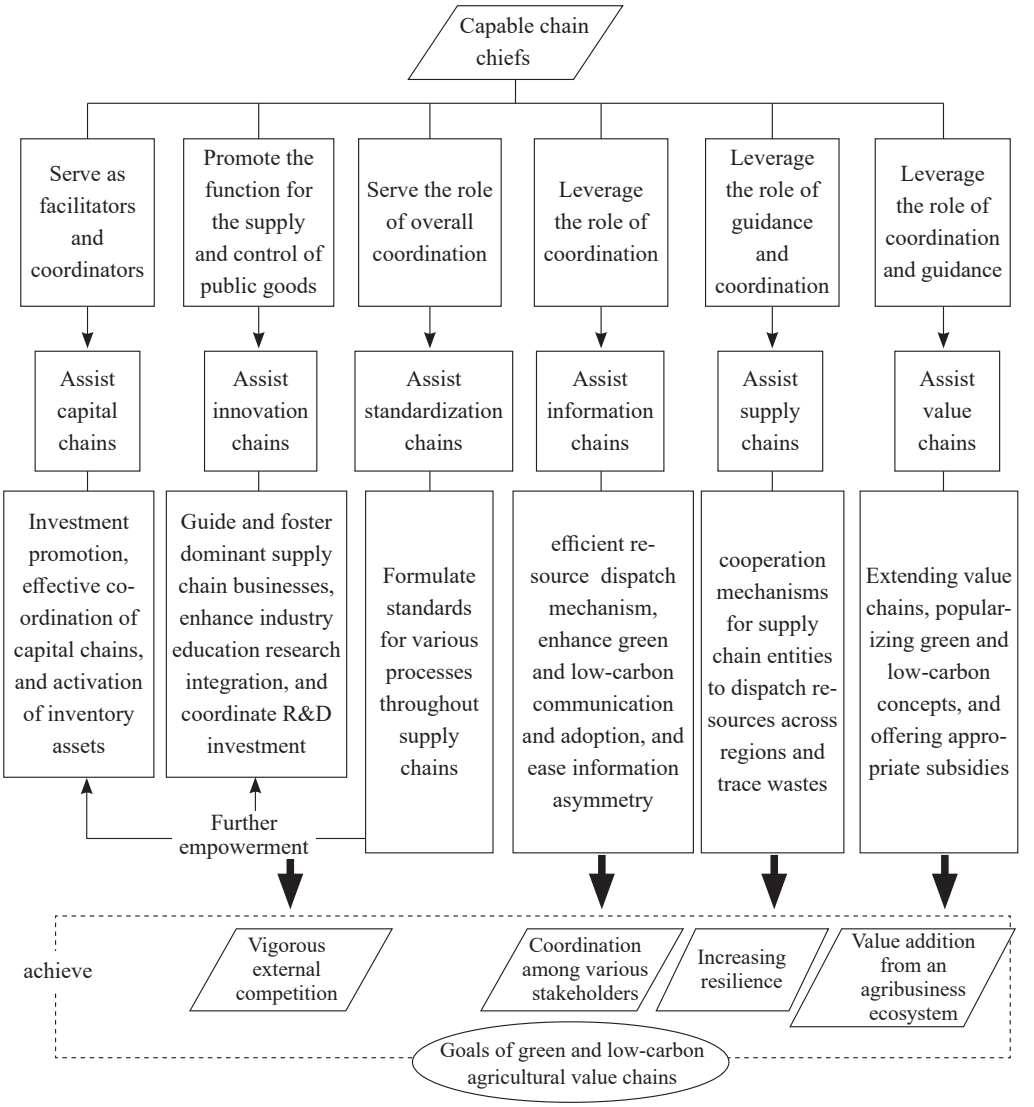

Figure 1: Paths by Which Capable Chain Chiefs Supporting Green and Low-Carbon Agricultural Value Chains

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4.1 Empowering Capital, Innovation and Standardization Chains to Realize Vigorous External Competition

Capable chain chiefs are essential to realizing vigorous external competition by activating the capital chain, strengthening the innovation chain, and developing the standardization chain.

Capable chain chiefs function as intermediaries, facilitators, and coordinators who infuse vitality into eco-friendly agricultural value chains (Research Group of the Institute of Industrial Economics of CASS and Qu, 2022). Promotion of investment to mitigate the scarcity of funds is a critical function of chain chiefs. Chain chiefs are more familiar with local situations. In order to support green and low-carbon agricultural value chains, it is their duty to attract capital and talent in accordance with local agricultural conditions and supply chains. The collection of detailed information regarding local entrepreneurs and businesses is the responsibility of investment promotion work groups that are organized hierarchically and directed by chain chiefs. Capable chain chiefs have the ability to recognize crucial supply chain operations and allocate regional resources, including the promotion of cross-border investment, in order to facilitate the efficient flow of regional resources. Capable chain chiefs are able to efficiently integrate capital chains. Traditional agricultural financial service institutions are less equipped to oversee the provision of green financial services than chain chiefs, who have access to more comprehensive market information. Regional agricultural digital finance platforms are used to connect banks and agribusinesses, as well as to provide green financial products for low-carbon agricultural value chains. Optimal coordination among green financial products for agriculture enhances the smooth movement of capital across supply chains. Capable chain chiefs are able to coordinate the standardization of agricultural green finance. The integration of environmental standards into credit and review procedures strengthens market-oriented green financial services that support eco-friendly agriculture across supply chains. Creating a cycle between existing investments and new assets, capable chain chiefs are ultimately responsible for activating the stock of idle and inefficient assets, such as rural land parcels, for the development of green and low-carbon agriculture.

Capable chain chiefs are responsible for the provision of public goods to enhance the innovation chain and increase the competitiveness of the supply chain. They provide guidance and policy incentives for dominant supply chain businesses to grow and invest more in R&D to become more innovative. Businesses are encouraged to develop and implement green and low-carbon agricultural processes and waste recycling technologies. Chain chiefs can promote the interconnection of green and low-carbon agricultural value chains within the region, increase industry-education-research collaboration, and establish R&D and innovation platforms for the commercialization of generic technologies for green and low-carbon agriculture. The chain chief is responsible for coordinating investments by local financial institutions and government authorities in developing green and low-carbon technologies. Priority can be given to creating an R&D fund for generic technologies to achieve breakthroughs in critical areas of green and low-carbon agricultural technologies.

Chain chiefs serve as coordinators who assist local governments in setting green and low-carbon agricultural value chain standards to meet the need for different types of green and low-carbon agricultural products. Standardization throughout the supply chains will strengthen the capital and innovation chains and increase the competitiveness of the external agricultural chain. General chain chiefs work together with regional chain chiefs to create and improve the seed tracing system, share seed information, and protect superior seed resources. Capable chain chiefs assist local agricultural authorities in conducting public communication and training programs for the standardized use of chemical fertilizers and pesticides. They oversee dominant supply chain enterprises in managing business reputation and brand image.

4.2 Assist the Information Chain in Increasing Synergy between Agribusinesses

Capable chain chiefs serve as coordinators in establishing an efficient resource dispatch mechanism

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on the basis of progression between general and regional supply chains. New-generation information technologies can be employed to increase coordination between agribusinesses, bridging the disconnects of green and low-carbon agricultural value chains. Using online platforms featuring the Internet of things (IoT), big data, cloud computing and block chain technologies, capable chain chiefs may fully leverage the digital economy's empowerment effect to expedite the creation of a green and low-carbon agricultural market, precisely and efficiently match supply with demand, and increase coordination and cohesiveness between upstream and downstream production and marketing businesses of all sizes. Not only may chain chiefs assist smallholders in accessing market information through digital applications, their role is also pivotal in the public communication and promotion of green and low-carbon technologies. Capable chain chiefs are supposed to train farmer households to use online platforms to access more information and mitigate information asymmetry.

4.3 Assist Supply Chains for Resilient and Continuous Enhancement

Capable chain chiefs provide guidance, coordination and overall planning to ensure the resilience of green and low-carbon agricultural value chains. They assist dominant supply chain businesses in addressing the contradictions between green and low-carbon agricultural value chain entities and establish cooperation mechanisms to share green cost and distribute profit under the repurchase contract. In this manner, market failures can be mitigated through collaboration between agribusinesses and farmers. It is the responsibility of capable chain chiefs to allocate resources across regions and adopt digital solutions for cold-chain logistics across regions. Cold-chain logistical channels should be created by sea, air and land routes to facilitate transportation and ensure timely delivery in case of contingencies during cold-chain transportation. Capable chain chiefs are expected to track agricultural waste by means of block chain technology and monitor and ensure proper waste treatment and recycling, contributing to supply chain resilience.

4.4 Assist Value Chains for Value Addition from Ecological Circulation

Capable chain chiefs ensure the permeation of green and low-carbon concepts for value added from an agribusiness ecosystem by enacting a series of incentives, penalties and development strategies. They are responsible for extending and broadening supply chains to explore the digital, cultural and ecological functions of green and low-carbon agriculture for the integrated development of primary, secondary and tertiary rural industries. In addition to raising awareness of green consumption, chain chiefs may also incentivize consumers to purchase green and low-carbon agricultural products, creating demand to boost the development of the eco-friendly agricultural value chains. CE

References:

[1] Cheng, Hua, Fengjun Lu, and Lijiao Xie. 2019. "Connotation, Evolution and Development Direction of Agricultural Industry Chain Organization in China." *Issues in Agricultural Economy*, 12: 118-128.

[2] Fan, Aijun, Zhiqiang Zheng, and Yongjian Ma. 2021. "Trade Policy, Global Value Chain Location and China's Carbon Dioxide Emissions." *Journal of Shandong University* (Philosophy and Social Sciences), 6: 138-149.

[3] Fu, Guohua. 1996. "Operation of Agricultural Products Industrial Chain to Improve the Efficiency of Agricultural System." *China's Agricultural Reclamation Economy*, 11: 24-25.

[4] Gao, Yang, Xue Yao, Yongxiu Bai, and Zhenlei Wu. 2022. "Active 'Chain Chief' Empowers Green and Low-carbon Agriculture Industry Chain: Internal Mechanism and Realization Path." *Economist*, 12: 116-124.

[5] Han, Xiyan, Wei Liu, and Zhifeng Gao. 2020. "Selection Preference and Preference Heterogeneity of Smallholders' Participation in Agricultural Industrial Chain: An Analysis Based on the Choice Experiment Method." *China Rural Survey*, 2: 81-99.

(C)1994-2024 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net

[6] Hirschman, Abert O. 1958. *The Strategy of Economic Development*. New Heaven: Yale University Press.

[7] Huang, Xianhai, and Xueyin Song. 2021. "Enabling Government: A New Theory of Government-Market Relation." *Journal of Management World*, 37(11):41-55+4.

[8] Huang, Yan, Ruirui Zuo, and Shufen Chen. 2018. "Influencing Factors, Mechanism and Growth Path of China's Agricultural Industry Chain." *Journal of Commercial Economics*, 6: 142-144.

[9] Jin, Minghua, and Qing Liu. 2019. "Research on the Profit Distribution of the Main Body of the Agricultural Industry Chain under the Background of 'New Retail'." *Academic Exchange*, 5: 104-113.

[10] Liang, Xiaojun, and Duo Hu. 2022. "Institutional Logic of Relative Poverty Governance under the Goal of Common Prosperity." *Study and Practice*, 7: 87-95.

[11] Lin, Shujun, and Hongfu Ni. 2022. "The Chinese-style Industrial Chain 'Chain Chief System': Theoretical Connotation and Practical Significance." *Social Sciences in Yunnan*, 248(04): 90-101.

[12] Liu, Xiuyan. 2009. "Agglomeration Economies and Labor Productivity: Evidence from Chinese Urban Panel Data." *Journal of Quantitative & Technological Economics*, 26(07): 109-119.

[13] Liu, Yiqiao, Xiaohong Xiao. 2022. "Leading Rural Revitalization with Green Development: Formation Mechanism and Evolution Path of Green Agricultural Industry Chain in Ethnic Mountainous Areas." *Journal of South-Central Minzu University* (Humanities and Social Sciences), 42(01): 148-156+187.

[14] Liu, Zhibiao, and Lingchi Kong. 2021. "The Chain Chief System under a 'Dual Circulation' Pattern – An Exploration on the New Form and Function of Local Leading Industrial Policies." *Journal of Shandong University* (Philosophy and Social Sciences), 1: 110-118.

[15] Liu, Zhibiao, and Yonghui Ling. 2021. "On Reshaping a New Industrial Chain under the New Development Pattern." *Economic Review Journal*, 5: 40-47+2.

[16] Mighell, Ronald L., and Lawrence A. Jones. 1963. *Vertical Coordination in Agriculture*. U. S. Government Printing Office.

[17] Porter, M. E. 1990. *The Competitive Advantage of Nations*. New York: Free Press.

[18] Qi, Zhenhong, and Peicheng Wang. 2010. "Coupling Mechanism of Low-carbon Agricultural Ecological Industry under Game and Interaction Theory." *Forum on Science and Technology in China*, 11: 136-141.

[19] Research Group of the Institute of Industrial Economics of CASS, and Yongyi Qu. 2022. "The Theoretical Connotation of the Central Enterprise as the Chain Leader of Industry Chain and the Function Realization." *China Industrial Economics*, 7: 5-24.

[20] Sheng, Zhaoxun. 2022. "From Industrial Policy to Industrial Chain Policy: Strategic Choice of Industrial Development in 'Chain Era'." *Reform*, 2: 22-35.

[21] Tu, Niansong, and Kaixiang Gong. 2022. "'Bringing in' and 'Going out' Technology Spillovers and Manufacturing Value Chain - A Study of the Threshold Effect Based on R&D Capabilities and Industrial Agglomeration." *Jinan Journal* (Philosophy & Social Sciences), 44(07): 64-79.

[22] Wang, Banban, Qionghui Mo, and Haoqi Qian. 2020. "The Diffusion Models and Effects of the Local Environmental Policy Innovation - A Micro-econometric Evidence from the Diffusion of River Chief Policy." *China Industrial Economics*, 8: 99-117.

[23] Wang, Kai, and Jinqin Han. 2002. "Preliminary Study on Agricultural Industry Chain Management." *Chinese Rural Economy*, 5: 9-12.

[24] Wang, Weiwei, and Yingliang Zhang. 2021. "Regional Brand Empowerment: An Effective Way for Small Farmers to Connect with Modern Agriculture." *Academic Journal of Zhongzhou*, 5: 36-43.

[25] Wen, Tiejun, Zhenghua Tang, and Yahui Liu. 2021. *From Agriculture 1.0 to Agriculture 4.0*. Beijing: Oriental Press.

[26] Yang, Qizhi. 2012. "Research on Low-Carbon Agricultural Development from the Perspective of Industrial Chain." *Academic Tribune*, 35(06): 119-122.

[27] Zhang, Gui. 2021. "To Seek the Focus of Building a New Development Pattern with the 'Chain Chief System'." *People's Tribune*, 2: 41-43.

[28] Zhang, Linxiu, Yunli Bai, Mingxing Sun, Xiangbo Xu, and Lin Jia. 2021. "Views on Agricultural Green Production from the Perspective of System Science." *Issues in Agricultural Economy*, 10: 42-50.

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