

The links between agriculture and health: an intersectoral opportunity to improve the health and livelihoods of the poor

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Abstract Agriculture and health are linked in many ways. First, agriculture is essential for good health: it produces the world's food, fibre and materials for shelter; in many countries it is also an important source of livelihood among the poor. At the same time, agriculture can be linked with poor health, including malnutrition, malaria, foodborne illnesses, human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), livestock-related diseases, chronic diseases and occupational ill-health.

Health also affects agriculture: people's health status influences the demand for agricultural outputs, and in agricultural communities, poor health reduces work performance, reducing income and productivity and perpetuating a downward spiral into ill-health.

This paper presents an overview of the bidirectional links between agriculture and health with a focus on the developing world. It develops a conceptual framework that brings together the various links between agriculture and health into a single broad framework. The framework comprises the core components of the agricultural supply chain (producers, systems and outputs), key health concerns and the mechanisms of common interaction between the agricultural and health components: income, labour, environment and access — all key social determinants of health.

These links between agriculture and health present an opportunity for the two sectors to work together to find solutions to each other's problems. Yet the health and agricultural sectors remain poorly coordinated. Leadership from global health and agricultural institutions is needed to build policies and good governance to facilitate integration, while capacity building is needed at all levels to help translate the conceptual links into comprehensive action on the ground. Health and agricultural researchers likewise need to work more closely together to achieve common goals.

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Introduction: identifying critical links between agriculture and health

It is well established that population health is strongly influenced by society and the environment. Social and environmental determinants of health include income, employment, access to food and social capital, and exposure to agents in air, water and soil.^{1,2} Although these determinants have been much studied, one important aspect of society and environment has as yet been inadequately addressed: agriculture.

Agriculture is essential for good health — it produces the world's food, fibre, and materials for shelter, and can produce medicinal plants; it is also an important source of livelihood for many of the poor in developing countries. At

the same time, agriculture can lead to poor health.³ As pointed out over 15 years ago by Lipton & De Kadt in their review of links between agriculture and health, agriculture is linked to the main causes of death and disease — malnutrition, infectious diseases and chronic diseases.⁴

Examining health in an agricultural context is therefore important because agriculture presents not only opportunities for improving health but also risks to health. It is equally important because health affects agriculture. In agricultural communities, poor health reduces income and productivity, further decreasing people's ability to address poor health and inhibiting economic development more broadly, while in the population at large, malnutrition and disease patterns influence market demand for agricultural products.

The links between agriculture and health are thereby bidirectional: agriculture influences health and health influences agriculture. This bidirectionality offers an incentive for the two sectors to work together — to orient agricultural systems to benefit health, and health systems to benefit agriculture.

The recognition of the importance of intersectoral work to health is not new.⁵ It was articulated recently by the Bangkok Charter for Health Promotion. "An integrated policy approach," it states, is "essential if progress is to be made in addressing the determinants of health."⁶ In agriculture, the emergence of joint animal and human health concerns such as avian influenza, and epidemics among agricultural communities such as that of human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS), have heightened

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the need for integrated action with the health sector.

Yet despite this opportunity and some awareness, the health and agricultural sectors remain poorly coordinated: health considerations play little part in the decisions farmers make about production or those that agricultural ministries make about policy, and likewise agricultural policies have a limited role in the health sector.⁴ There are reasons for this disjuncture, some resulting from lack of awareness, others from distinct policy conflicts. But whatever the challenges, these divisions are undermining efforts to overcome ill-health among impoverished communities, and giving short shrift to agriculture's role in alleviating many of the world's most serious health problems.

The objective of this paper is to highlight the potential advantages of closer interaction between the health and agricultural sectors by presenting a conceptual framework of agriculture–health links, and illustrating how these links operate in specific settings in the developing world.

The conceptual framework: how is agriculture linked with health?

The conceptual framework (Fig. 1) was developed following a review of the scientific literature on agriculture and health, including existing models with agriculture–health components, such as the ecohealth approach.^{2,4,7–16} The search was undertaken in three databases (PubMed, ISI Web of Science and CAB

Direct) for publications from 1980 onwards, limited to those in English. The initial search terms were “agriculture” and “health” later refined by searching for particular health conditions and agricultural practices.

Key health conditions: significance to global public health

The first step in the development of the framework was to identify the key health conditions and risks, diseases and groups of diseases, associated with agriculture. In the currently available literature, the following health problems — all of which affect the poor in developing countries — were identified as being linked in some way with agriculture: malnutrition, water-associated vector-borne diseases, foodborne illnesses, HIV/AIDS, livestock-related illnesses (zoonoses), chronic diseases and particular occupational health risks. (It is likely that other health conditions are also linked with agriculture, but they have not yet been explored in the published literature.) The framework thus specifies and unites an array of key global health concerns, which interact when present in the same context.

Key agricultural components: the supply chain

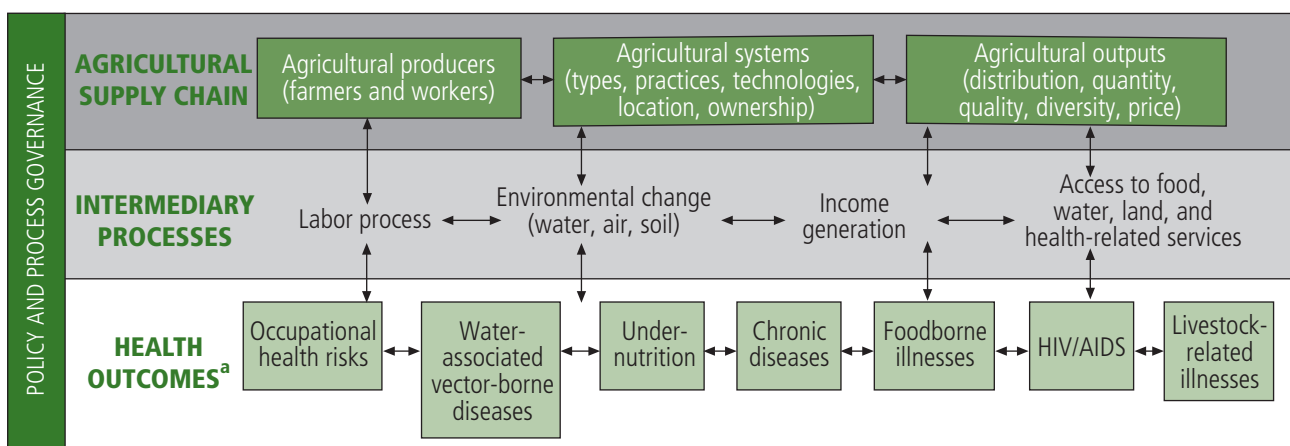
The second step was to look at how agriculture is associated with these health conditions. Scientific studies tend to focus on one part of the agricultural supply chain (e.g. agricultural producers and occupational health risks; agricultural outputs and foodborne disease).

But by considering the different types of literature together, it becomes clear that the entire agricultural supply chain has implications for health: agricultural *producers* (i.e. both farmers and agricultural workers) are particularly vulnerable to malnutrition and disease because they often have limited resources; agricultural *systems* influence human health through interactions with the environment which affect agricultural outputs; and agricultural *outputs* — food, fibre, materials for shelter and some medicinal plants — are essential for human health but also present risks. Producers, systems and outputs also represent potential points of intervention to achieve greater synergies with health.

Key intermediary processes: the social and environmental determinants of health

The final step in the development of the framework was to identify the common processes mediating the relationships between the agricultural supply chain and the different health conditions. From the literature, it emerged that four interlinked social and environmental determinants of health are critical: income (amount, type, stability, distribution and control of), labour (amount available, type, location, energy and time expended), access to food, water, land and health-related services (e.g. medicines, bednets and hospitals) and environmental changes in water, air and soil. The role of the intermediary processes, together with the rationale behind the identification of the health conditions, is elaborated on in the next

Fig. 1. Conceptual framework of the links between agriculture and health



^a These health conditions are not mutually exclusive — livestock-related illnesses, for example, are also occupational health risks. The list of health outcomes is not necessarily inclusive. Other health conditions are also likely to interact with agriculture, but these have not yet been identified as such in the published scientific literature.

section, which looks at each component of the agricultural supply chain.

Rationale and explanation of the bidirectional links Agricultural producers

Working as an agricultural producer (as a farmer or labourer) is a determinant of health, largely via the intermediary processes of income and labour.⁴ Agricultural households earn income from agriculture, which in turn influences their ability to purchase and gain access to food, water, land and health-related services and thus determines their overall health status. By affecting their access to food, the amount, type, stability and distribution and control of income also has important implications for the nutrition of agricultural households.^{7,10,12,13}

The labour supplied by agricultural households interacts with health in several ways. First, labour influences nutritional status by affecting energy expenditure and the time available for child care and food preparation.^{7,10,12,13} Second, farming exposes producers to a range of occupational health hazards, such as dehydration, accidents, zoonoses, and acute and chronic pesticide poisoning.¹⁷ Third, the amount and type of agricultural employment has implications for the spread of and exposure to disease (e.g. HIV/AIDS) because it influences migration and the search for alternative income sources.⁸ All these interactions are affected by gender relations in agricultural communities.

In the other direction, malnutrition and poor health in agricultural communities affect people's ability to gain a livelihood from agriculture by affecting their capacity to work and generate food and income. The problem is graphically illustrated by the case of HIV/AIDS, which has devastated agricultural communities in sub-Saharan Africa. The resilience of communities to these negative shocks depends partly on intermediary social determinants such as access (including cost) to health-related services and food.

Agricultural systems

Agricultural systems vary hugely — by commodity type, practices and technologies used, location and ownership system. The types and severity of diseases associated with the agricultural system thus vary with these different factors. In livestock production, for example, different animals are associated with different

zoonoses (e.g. working with dairy cows and sheep is a risk factor for brucellosis). The influence of agricultural systems on health is particularly notable via the intermediary process of environmental change.^{18–20} As exemplified below, water-associated vector-borne diseases are a particularly important group of diseases affected by this interaction.

In the other direction, health affects agricultural systems: poor health reduces the ability of producers to innovate, invest in and operationalize changes in agricultural systems — including changes that promote health.⁴

Agricultural outputs

Agricultural outputs affect health in a variety of ways. The major output — food — can carry foodborne illnesses and affects nutrition. Foodborne illnesses are caused by unsafe food that may originally have been contaminated during agricultural production. For example, pathogens on raw fruits and vegetables may be the result of irrigation with inadequately treated wastewater, and aflatoxins may be present in staple crops (as exemplified below).^{14,21,22} Nutrition is influenced by the quantity of food available, its quality and diversity, its price and how it is distributed, which in turn are influenced by agriculture and the policies that govern it.^{7,10,13,23–26}

Agricultural outputs are also linked with chronic diseases. Agricultural policies can create incentives or disincentives to the production of different foods, tobacco and alcohol, and in turn determine their prices, thus affecting the environment in which people make choices about these products, and their subsequent level of exposure to risk factors for chronic disease.^{27,28}

Another agricultural product is medicinal plants, many of which are believed to be effective in the treatment of certain diseases.²⁹ Incorporating production of medicinal plants into agricultural systems, such as agroforestry, has the potential to address some of the problems related to over-harvesting of medicinal plants in the wild, while meeting the demand for these plants on global export markets.³

In the other direction, health affects people's abilities, needs and desires to consume different amounts and types of food, which in turn affects demand from agricultural systems and the types of products. Even if a health condition is not present, the risk of ill-health may

create or reduce demand for outputs with specific qualities. Concerns about foodborne illnesses or diet-related chronic diseases, for example, can reduce demand or create demand for certain foods over others.^{30,31}

Consequences of links between agriculture and health in specific settings

Two examples are presented below to illustrate the consequences of these bidirectional links for the health and livelihoods of vulnerable groups in local settings, and the potential for innovative, linked solutions.

Water resource development, crop production and malaria

The development of water resources for agriculture is a good example of how practices characterizing an agricultural system interact with the intermediary processes of environment, income and labour to affect health. Irrigation, multipurpose dams, and ponds for livestock and fish can benefit health by increasing food yields and production, and generating higher incomes for the producers; on the other hand, they can also create conditions suitable for the propagation of insect vectors and intermediate hosts of pathogenic parasites, thus introducing or intensifying the transmission of water-related vector-borne diseases, such as malaria, schistosomiasis and Japanese encephalitis.⁹

Mutero et al. compared the impact of these interactions on malaria in Mwea Division, Kenya, between villages with and without rice irrigation.³² They found that villages with rice irrigation had a 30–300 times higher prevalence of the local malaria vector, yet paradoxically, a lower prevalence of malaria (0–9% compared with 17–54%). One potential explanation for this so-called “paddies paradox” was that households engaged in irrigated agriculture had higher incomes and were thus more able to pay for malaria treatment and bednets. But although average cash income in the villages using irrigation was higher, poverty was rife in all villages and there was no evidence that people in the villages with irrigation made greater efforts to protect themselves. The suggested alternative explanation came from another agriculture–environment component: that in the irrigated villages, mosquitoes were more likely to feed off the cattle kept for economic reasons, thus diverting

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them from humans as a source of blood-meal and reducing disease transmission.

In the other direction, malaria affects agricultural producers by reducing their ability to work. A study in an area of intensive vegetable farming in Côte d'Ivoire showed that malaria led to absences from work of between 0–26 days in a 10-month period; this in turn was directly correlated with reduced overall yields and revenues.³³

The links between malaria and agriculture present opportunities for innovative approaches to address poor health and livelihoods.³⁴ Management of agricultural water has been shown to reduce morbidity and mortality from malaria.³⁵ In a case reported from Sichuan province, China, a shift in irrigation techniques to an annual cycle of wet crop/dry crop rotation resulted in a reduction of vector breeding to a level lower than that required to sustain malaria transmission.³⁶ Other potential approaches include keeping cattle as deliberate bait, and combining health interventions (i.e. distribution of bednets) with irrigation programmes.

Aflatoxins, agriculture and health

Aflatoxins are a good example of how contaminated agricultural outputs have implications for the health of local and global populations. Aflatoxins are highly toxic metabolites produced by a fungus which develops during the production, harvest and storage of staple crops. Eating foods contaminated with high levels of aflatoxins leads to acute aflatoxicosis, and regular consumption even of low levels is associated with stunting and underweight among children and the development of hepatocellular cancer in low- and middle-income countries.^{37–39} In West Africa, studies by Gong et al. and Egal et al. have shown that 90% of children in Benin and Togo were exposed to aflatoxins in maize and groundnuts, which led to a measurable impairment of child growth.^{38,40–42}

As a result of international trade in staple foods, the health impacts of aflatoxin can extend far beyond local communities.¹⁴ This has led food-importing countries to define regulatory standards; if levels of contaminants exceed the standard, they will not be imported. Such standards have implications for the

livelihoods of agricultural communities in exporting countries. Otsuki et al. used a model to compare the impact of a regulatory standard proposed by the European Union in 1997 on African food exports, with the impact of the international standard.⁴³ They concluded that the regulation would have led to declines in African exports of cereals, dried fruits and nuts worth US\$ 670 million in exchange for one or two lives saved in the EU. This result implies that a balanced trade-off is needed between the direct health risks posed by aflatoxins and the indirect health risks presented by potentially lowered incomes in agricultural communities.

But again, when the interactive nature of the problem is taken into account, relatively simple solutions to these risks to health and livelihoods can be identified. For example, a recent study showed that low-cost agricultural interventions such as using wooden pallets for crop storage reduced exposure to aflatoxins in local communities in West Africa by more than half.⁴⁴

Conclusion: applying the framework in policy and practice

The conceptual framework and examples presented here show that agriculture can provide the environmental and/or economic conditions conducive to the spread of disease, but can also provide the conditions conducive to the prevention and control of disease. They demonstrate the importance of examining the links within a broad framework that considers the different pathways, given that the multiplicity of interactions can produce unexpected outcomes and trade-offs.

The conceptual framework can be used to advance intersectoral policy and practice in three main ways. First, it can be used to communicate to decision-makers and the international development and donor communities the importance of examining the links between agriculture and health: failing to think systemically about these links may be undermining their efforts to improve agricultural livelihoods and address diseases of public health importance — avian influenza being one example. Second, it can be used encourage researchers working at the intersection

between agriculture and health to come together to form a larger and stronger community. Microbiologists working on food safety, social anthropologists examining the impacts of HIV/AIDS in rural areas, and public health nutritionists concerned about the healthiness of the food supply may not think they have anything in common, but they do: they all work on the interactions between agriculture and health. Moreover, bringing together workers in this surprisingly large field increases the evidence base from which lessons can be learned to solve linked problems. Third, the conceptual framework can be employed to encourage capacity building at all levels, including local settings. This approach is needed to identify where and how the livelihoods of the poor are most affected by the interactions, and where agricultural and/or health interventions would be most effective.

Four main steps are required to encourage greater synergies between agriculture and health. First, individuals and institutions already active in the field of links between agriculture and health should compile and communicate evidence of successes and failures and share their knowledge and experience. Second, institutions concerned with global health and agriculture should build capacity, policies and governance structures to facilitate linked approaches, starting by setting up forums to bring the stakeholders together. Third, agricultural and health researchers should — together — identify and prioritize research gaps and needs, and develop a joint research agenda; and fourth, all stakeholders should invest in capacity building to help translate the conceptual links into comprehensive action on the ground. The goal is clear: healthier people and healthier agriculture. ■

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Résumé

Exploiter les liens intersectoriels entre agriculture et santé pour améliorer la santé et les moyens de subsistance des plus démunis

Il existe de nombreux liens entre agriculture et santé. Tout d'abord, l'agriculture est indispensable à la santé : elle produit les aliments dont se nourrissent les humains, ainsi que des fibres et des matériaux pouvant servir à les abriter. Dans nombre de pays, c'est aussi un moyen de subsistance important pour les plus démunis. Dans le même temps, des relations peuvent être établies entre agriculture et mauvaise santé : malnutrition, paludisme, affections d'origine alimentaire, VIH/SIDA, maladies transmises par le bétail, maladies chroniques et troubles d'origine professionnelle.

La santé exerce aussi une influence sur l'agriculture : l'état de santé des individus a des effets sur leur demande en produits agricoles et dans les communautés agricoles, un mauvais état de santé des membres diminue les performances professionnelles, les revenus et la productivité, entretenant ainsi une spirale descendante vers la détérioration de la santé.

Le présent article donne un aperçu des relations bidirectionnelles entre agriculture et santé, l'accent étant mis sur le cas des pays en développement. Il présente un cadre conceptuel unique et général, capable de regrouper l'ensemble de ces divers

liens. Ce cadre intègre les principales composantes de la chaîne d'approvisionnement agricole (producteurs, systèmes et produits), les préoccupations sanitaires majeures et les mécanismes d'interaction courants entre l'agriculture et les déterminants sanitaires et sociaux suivants : revenus, environnement de travail et accès aux soins et à l'alimentation.

L'existence de ces liens entre agriculture et santé devrait inciter ces deux secteurs à collaborer pour trouver des solutions à leurs problèmes respectifs. Cependant, la coordination entre le secteur de la santé et celui de l'agriculture est encore très limitée. Il faudrait que les organismes représentant ces secteurs à l'échelle mondiale élaborent des politiques et des règles de bonne gestion facilitant une prise en compte globale de leurs problèmes et que les moyens pouvant contribuer à la transposition de ces liens conceptuels en interventions sur le terrain de grande portée soient renforcés à tous les niveaux. Les chercheurs en santé et en agriculture ont besoin les uns comme les autres de collaborer étroitement pour atteindre des objectifs communs.

Resumen

Interacción entre la agricultura y la salud: una oportunidad intersectorial para mejorar la salud y los medios de vida de los pobres

La agricultura y la salud están relacionadas de muchas maneras. Ante todo, la agricultura es esencial para una buena salud: produce alimentos, fibra y material de abrigo; en muchos países es también una fuente importante de medios de subsistencia para los pobres. Pero al mismo tiempo la agricultura puede asociarse a problemas de salud, como malnutrición, malaria, enfermedades transmitidas por los alimentos, la infección por el virus de la inmunodeficiencia humana/síndrome de inmunodeficiencia adquirida (infección por VIH/SIDA), enfermedades relacionadas con el ganado, enfermedades crónicas y enfermedades ocupacionales.

La salud también influye a su vez en la agricultura: la situación sanitaria de la población influye en la demanda de productos agrícolas, y en las comunidades agrícolas la mala salud reduce el rendimiento del trabajo, reduce los ingresos y la productividad y perpetúa una espiral de deterioro de la salud.

En este artículo se presenta un panorama de las relaciones bidireccionales entre la agricultura y la salud, centrado sobre todo en el mundo en desarrollo. Se elabora un marco conceptual que

integra las diversas relaciones entre la agricultura y la salud en un solo esquema general. Se inscriben en ese marco los componentes básicos de la cadena de suministro agrícola (productores, sistemas y productos), las principales preocupaciones en materia de salud y los mecanismos de interacción habituales entre los componentes agrícola y sanitario: ingresos, trabajo, medio ambiente y acceso: todos ellos determinantes sociales clave de la salud.

Esos vínculos entre la agricultura y la salud brindan a los dos sectores la oportunidad de colaborar y buscar cada uno soluciones para los problemas del otro. Sin embargo, son dos sectores que siguen estando mal coordinados. Se necesita el liderazgo de las instituciones mundiales relacionadas con la salud y la agricultura para elaborar políticas, y una buena gobernanza que facilite la integración, y paralelamente se debe crear capacidad a todos los niveles para ayudar a traducir los vínculos teóricos en acción integral sobre el terreno. Asimismo, los investigadores sanitarios y agrícolas necesitan colaborar más estrechamente para alcanzar metas comunes.

ملخص

الروابط بين الزراعة والصحة: فرصة سانحة أمام قطاعات متعددة لتحسين صحة الفقراء ومكانتهم

والصحة في إطار عملي واحد وعريض. ويتألف الإطار العملي هذا من مكونات أساسية لسلسلة الإمداد الزراعي (المنتجون والنظم والمنتجات)، والقضايا الصحية الأساسية، وآليات التبادل في التأثير المشترك بين المكونات الصحية والزراعية، وهي الدخل والعمل والبيئة والإتاحة، وهي جميعها من المحددات الاجتماعية الرئيسية للصحة.

وتقدم هذه الروابط بين الزراعة والصحة فرصة للقطاعين الصحي والزراعي للعمل معاً لإيجاد حلول لما يعانيه كل منهما من مشكلات. ومع ذلك لا يزال التنسيق بين الصحة والزراعة ضئيلاً. وتمس الحاجة إلى قيادات على الصعيد العالمي من الصحة ومن المؤسسات الزراعية لبناء السياسات والحوكمة الجيدة لتسهيل التكامل، فيما تمس الحاجة أيضاً إلى بناء القدرات على جميع المستويات للمساعدة في ترجمة الروابط المفاهيمية إلى أعمال شاملة في الواقع. كما تمس حاجة الباحثين في الزراعة والصحة للعمل الوثيق معاً لتحقيق الأهداف المشتركة بينهما.

ترتبط الصحة بالزراعة بأواصر متعددة، فالزراعة أولاً ضرورية للمحافظة على صحة جيدة، فهي تنتج للناس الطعام والألياف والمواد التي تؤمن لهم المأوى، وهي أيضاً من المصادر الهامة في الكثير من البلدان لكسب الرزق للفقراء. إلا أن الزراعة قد ترتبط من ناحية أخرى باعتلال الصحة، والذي يشمل سوء التغذية والملاريا، والأمراض المنقولة بالغذاء والإيدز والعدوى بفيروسه، والأمراض المرتبطة بالماشية والأمراض المزمنة واعتلال الصحة الناجم عن المهنة.

وبالمقابل تؤثر الصحة على الزراعة، فالحالة الصحية لدى الناس تؤثر على المتطلبات اللازمة للحصول على المنتجات الزراعية، كما يؤدي اعتلال الصحة في المجتمعات الزراعية إلى خفض الدخل والإنتاجية ويفاقم من اعتلال الصحة أكثر فأكثر.

وتستعرض هذه الورقة نبذة عامة عن الروابط الثنائية الاتجاه بين الزراعة والصحة، مع التركيز على البلدان النامية. وتضع الورقة أيضاً إطاراً عملياً مفاهيمياً للعمل يجمع بين مختلف الروابط التي تصل بين الزراعة

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