



Wheat as food, wheat as industrial substance; comparative geographies of transformation and mobility

Jennifer Atchison *, Lesley Head, Alison Gates

School of Earth and Environmental Sciences and GeoQuEST Research Centre, University of Wollongong, Wollongong 2522, Australia

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ABSTRACT

Wheat is the world's second largest crop, supplies 19% of human calories, and is the largest volume crop traded internationally. Its uniquely malleable physical properties make it a valued industrial substance, albeit often an invisible one, as well as a food. This combination of transformation, invisibility and mobility demands new ways of thinking about wheat geographies. In this paper we document and analyse several 'moments' in the life of Australian wheat; at the supermarket, in the lives of coeliac sufferers, in laboratories, industrial factories and on the farm. We illustrate diverse patterns of interaction with wheat. The major plane of differentiation is between wheat as food and wheat as industrial substance. The explicit connection of food to the human body tends to fix the identity of wheat, whether as healthy staple of the nation, or harmful poison to coeliacs who must negotiate its presence using the regulatory regime of food labelling. This is no small task given the ubiquity of wheat; our survey of 10,235 supermarket items found it in 29.5% of labelled food items. In contrast, when wheat is physically and chemically disassembled to become an industrial substance, its presence and identity become mutable, hidden and often invisible.

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1. Introduction

A major challenge for contemporary agri-food geographies is to work across, and eventually dismantle, a set of binary oppositions that have marked the field: culture and nature; conventional and alternative agriculture; global and local processes; production and consumption; political economy and cultural approaches; foci on materiality and representation (Morgan et al., 2006). The complexity of food security and agricultural sustainability questions in both developed and developing parts of the world demands more integrative and cross-cutting thinking. In this paper we contribute to this process by working across a further dualism, that between food and industrial substance, using the example of wheat.

We aim to contribute to a more dynamic spatiality of this major crop, one attuned to the material qualities of the wheat itself. Wheat's unique qualities enable it to be both food and non-food product in very particular ways. As the largest volume crop traded internationally, the mobility of wheat commands attention. However, the craftable qualities of wheat can render it invisible, defying attempts to 'follow the thing' (Cook, 2004) using 'mobile methods' (Larsen et al., 2006, p. 6). So the question 'where is the wheat?' cannot be answered without considering a further question; 'what is wheat?' Our study examples come from several 'moments' in the

life of Australian wheat; at the supermarket, in the lives of coeliac sufferers, in laboratories, industrial factories and on the farm. The comparison here between wheat as food and wheat as industrial substance shows quite different patterns of fixing the identity of wheat. Food tends to fix the identity; non-food tends to hide, make invisible and disassemble the identity of wheat. We first site the study in the food geography and mobility literatures, then explain in more detail the significance of wheat geographies.

2. Agri-food geographies and mobilities

Because food is central to the interactions between human bodies and the nonhuman world, it is not surprising that heated discussions around the concepts and practice of cultures/natures have been central to food geographies over the last decade. Goodman (1999) argued that this field, where nature was 'abstracted from the social domain' (p. 17), was in fact rather late to examine its basis in modernist ontology. He advocated actor-network theory as a potential way forward, an argument challenged by Marsden (2000), who argued that ANT, while offering 'a better methodological tool kit' could not sufficiently account for the power differentials evident throughout agricultural networks. Marsden suggested that empirical studies with a 'significantly more micro-sociological stance' (p. 27) would provide a way forward. Goodman noted that food scares, prominent in the Anglo-American literature because of bovine spongiform encephalopathy (BSE) and concerns over genetically modified (GM)

* Corresponding author.

E-mail address: jennya@uow.edu.au (J. Atchison).

food, are episodes ‘when the hybrid co-productions of natures-cultures that make up human food practices are revealed and re-negotiated’ (Goodman, 1999, p. 28).

Winter's (2003, 2005) reviews identified a number of promising connections across the divides, including Whatmore's (2002) now classic work on hybridity. He particularly drew attention to the ‘discovery of ‘culture’ in economic geography’ (2003, p. 505) and to a series of ethnographic studies among farmers (p. 510), but noted the risk that this could prove just as essentialist as older political economy approaches. A number of studies attempted to cross the acknowledged divide between production and consumption (Goodman and DuPuis, 2002), including those that developed methodologies to ‘follow the thing’ (De Sousa and Busch, 1998; Cook, 2004; Cook et al., 2006). A flurry of studies on particular foods provided not only more mobile and multi-sited ethnographies, but attention to the material qualities of the nonhuman in question, whether bananas, papayas, tomatoes or coffee. The material was frequently positioned in opposition to the representational turn in cultural approaches, leading Kearnes (2003) to critique the way the material was often given *a priori* significance, and to argue that we need a notion of ‘matter as simultaneously – and unevenly – discursive and physical’ (150, emphasis added). The empirical context of Anglo-American studies such as those reviewed by Cook et al. (2006) was most frequently alternative food networks and fair trade movements.

A further relevant trend has been the link between embodied geographies and the way that things become food, as seen in the work of Roe (2006a,b). Roe uses examples such as fish becoming sushi, James preparing organic potatoes, and focus groups engaging with carrots. Her works remind us that food should not be given ontological status, but rather that the process of ‘becoming’ food involves relations between humans and nonhumans (plants and animals). Nor is that process even across all human groups, as the coeliac example in this paper shows.

As mentioned above, the methodology of ‘following the thing’ is very similar to the ‘mobile methods’ in human mobility studies. The latter include both the researcher moving ‘along with the people, images or objects that are moving and are being studied’, and second ‘capturing through observation, questionnaires, interviews, mapping and traces, the complex mobilities of the people, images and objects under study’ (Larsen et al., 2006, p. 6). Much recent mobility research has focused on the complex movements of people (Cresswell, 2006), for example in social networks and travel (Larsen et al., 2006), and in the process of migration (Blunt, 2007). Featherstone et al.'s (2005) collection on ‘automobilities’ is helpful to us in two main ways, conceptual and methodological. In this work the ‘driver-car’ (Dant, 2005, pp. 61–62) is explored as an assemblage, ‘a form of social being that produces a range of social actions. . . driving, transporting, parking, consuming, polluting. . . and so on’. Urry (2005, p. 26) conceptualises the ‘system of automobility’, which

involves autonomous humans combined with machines with capacity for autonomous movement along the paths, lanes, streets and routeways of one society after another. What is key is not the ‘car’ as such but the system of these fluid interconnections.

In following wheat we aim to do so in a way that does not reify it as a preconstituted ‘thing’, but is attuned to, on the one hand, its material deconstruction and transformation into things other than wheat, and on the other, to its interactions with the bodies of humans and others.

3. Why wheat?

Wheat is immensely significant in the global food supply, being the second largest crop produced and consumed by volume

(Table 1), and supplying 19% of world calorific supply (Mitchelle and Milke, 2005). It is the crop with the largest production area and a lower global average yield than corn or rice, making its production more energy intensive. It is the largest volume crop traded on an international scale, the most significant crop for international food aid, and the most significant crop stored as a buffer against production shortages (Mitchelle and Milke, 2005). Perhaps surprisingly, it has been less part of recent agri-food conversations than for example soybeans (De Sousa and Busch, 1998; Whatmore, 2002).

Wheat has been turned into money since our ancestors recognised its starchy, floury and kneadable qualities. Its distinctive physical characteristics are central to its transformability and contemporary industrial applications. All conventional grain crops are significant sources of carbohydrates (both starch and sugar) but wheat contains considerably more protein than rice, maize, barley or millet (Pomeranz, 1988). Although soybeans have a higher protein content, they do not contain comparable quantities of carbohydrates. Wheat can thus become a component of hairspray, paper and milk via contemporary agricultural and industrial modes of production and processing. It moves in nonlinear ways, hides, and in turn transforms other things.

Australian wheat is a key component of this global industry, representing about 15% of annual wheat trade (ABS, 2006). Although the area under production has waxed and waned (Henzell, 2007), production today surpasses all historical highs. In 2003–2004 the gross value of wheat production was estimated at around \$5.6 billion, about 26 million tonne in wheat (ABARE, 2006), representing about 15% of Australia's agricultural production (ABS, 2006).

4. What is wheat? The flexibility of wheat

Plant geographies are usually approached via different types of collectives or assemblages; forests, food, commodities, vegetation communities, habitat, biodiversity and, more recently, carbon storage devices. ‘Wheat’ is another such collective, one that defies our efforts at defining and describing its geography in several ways. First, its botanical taxonomy is enormously complicated, with all attempts at its systematic classification proving very difficult (Morrison, 2001). Wheat is an ethnobotanical term rather than a specific taxonomic identity. It encompasses two genera (*Triticum* and *Aegilops*, Morrison, 2001) and approximately 600 species (Cornell and Hovelung, 1998). The taxonomy is complicated by the existence of multiple genetic strains, and by its huge genetic diversity, which is about six times larger than the maize genome (Huttner and Debrand, 2001); the result of complicated historical and ongoing interbreeding and hybridisation by humans over thousands of years of domestication (Feldman, 2001).

Second, the wheat grain or kernel itself can be understood differently, depending on the context in which it is examined and useful (Evers and Bechtel, 1988). In the flour mill, the kernel is ‘sheared’, ‘reduced’ or ‘broken apart’ physically into components labelled in the commercial environment (and also domestically) as flour, semolina, bran and germ. Although these components are broadly applied and widely used (Evers and Bechtel, 1988), they have no strict or definitive meanings and are understood in this environment to be ‘variable commodities’ because of the natural variations in the source grain (BRI, 1989). In the botanical text book, the morphology of the kernel is understood via cellular structures identified using microscopic imagery and labelled according to ‘precise’ botanical terminology even though individual grains vary considerably from the gross average (Evers and Bechtel, 1988). In the laboratory and industrial factories, flour produced in the flour mill, is pulled apart, isolated or fractionated via

Table 1
Global production, consumption and trade statistics for the leading agricultural food crops 08/09. Source: USDA (2009a,b).

	Wheat	Corn	Rice	Soybean
Production area Million hectares	224.93	156.40	155.71	96.71
Production Million metric tonnes	682.184	787.3	443.65	210.91
Consumption Million Metric tonnes	632.4	777.5	432.0	Not available
Total imports (MMt)	132.2	76.1	26.3	74.4
Total exports (MMt)	135.0	77.9	29.0	75.3

chemical processes into substances which are understood as having particular chemical properties (such as the ability to form gels), but which are themselves assemblages or categories of constituent things; carbohydrates (as different types of starches and sugars), proteins (as gluten fractions), fats and lipids, fibres, enzymes, and many other compounds (Pomeranz, 1988).

Each of these approaches to understanding and utilising the kernel underpin wheat's versatility to be broken down into constituent parts or compounds and then also to be reassembled and reconstituted to make other things, both food and non-food products (Cornell and Hovelung, 1998). Milled flour is used to make traditional food products such as bread, noodles and pasta. It is also processed into glucose or maltodextrin, additives which are found in sweets and snack foods. Additionally it is manufactured into food colours and food flavours. Milled flour is also refined in the industrial factory into starch to make adhesives in box manufacture; additives in biodegradable 'plastic' packaging; source stock for renewable fuels (like ethanol); and alcohols for use in industrial textiles, pharmaceuticals, inks, cleaners, propellants for perfumes, cosmetics and personal care products (Manildra Group, 2008).

There is thus a central ambiguity in our work that challenges not only the essentialism of food but the essentialism of wheat itself. We wrap a category around a taxonomically complex set of plants and call it wheat. Just as other domesticated food plants emerge as 'countless', 'impossible to avoid' (Cook, 2004) and 'invisibly ubiquitous' (Whatmore, 2002), wheat is – even more so – simultaneously visible and invisible, obvious and hidden, everywhere and nowhere.

5. Methods

In keeping with the complexity of the networks under discussion, a combination of methods has been appropriate. Our two main methods are a survey of supermarket products and their labels for the presence and absence of wheat, and interviews with people who negotiate the presence and absence of wheat in different ways.

5.1. Surveying the wheat

A major component of market share in the contemporary Australian retail industry belongs to the supermarket, where thousands of products are displayed. Online supermarket shopping services present one opportunity to access and research a publicly available list of retail products. Australia has one of the highest concentrations of market share in the retail food sector with companies Woolworths and Coles controlling possibly as much as 80% (ACCC, 1999) of the industry. These companies play significant roles in both horizontal integration, having branched into spheres such as petrol and perishable foods, and vertical integration with investment in the supply chain. Woolworths online shopping lists were selected for this case study primarily because there were more local retail outlets to field check the ingredients of the items on these lists.

Wheat is an important component of supermarket products because it remains a central part of Australian diets. Although consumption of grain for food has decreased since the Second World War (ABS, 2000), a 1995 survey (ABS, 1999) found that adult Australians consume about 11.1 kg of pasta, 4.7 kg of sweet and savoury biscuits, and 20.5 kg of cakes, pastries, buns, muffins, and scones per person per year. Over 90% of Australians consumed cereals and cereal-based products (bread, breakfast cereal, pasta, but also including rice) and 67–81% of Australians consumed cereal-based products and dishes (biscuits, cakes, pastries, pizza, lasagne, hamburgers, etc.) (ABS, 1999).

Food labels are not provided in virtual supermarkets and so we visited supermarkets to field check product labels for the presence or absence of wheat. Of the 12,034 items listed on the Woolworths online shopping lists, 10,235 were available on the shelves to look at. Availability varied according to factors including seasonality (e.g. Christmas hampers), locality preferences (e.g. high proportions of organic items were not available in some stores), recalled and discontinued items, and an item's suitability for home delivery service. Unknown ingredients and additives were checked against the literature for potential wheat derivation.

5.2. Interviews

We draw on seven interviews undertaken in 2006–2007 with people involved in processing wheat (food scientists, stock feed millers, a fast moving consumer goods merchandiser, a starch scientist, dairy and pig farmers). The semi-structured interviews included common questions about people's interactions with wheat, and more detailed follow up questions relating to their particular circumstances. All interviews were digitally recorded and transcribed. People were interviewed in their workplaces. Some of these were accessible to us for detailed observation, but others were restricted due to health or security regulations, or commercial confidentiality. In presenting this material we aim to illustrate the ways in which wheat is physically transformed into food and other stuff and the diverse ways it becomes mobile. We also endeavour to 'flesh out' the space-time where wheat becomes "affected and thus altered by what is done to it", in part exploring "the meaning-making" enacted by how the foodstuff is handled (Roe, 2006a, p. 109). In this way we contribute to a more embodied experience of production (Lockie, 2002).

For many Australians wheat is so much a part of daily life that we interact with it unconsciously. In contrast, sufferers of coeliac disease have to be highly attuned to its presence and absence. Bell and Valentine (1997) have previously discussed the profound limits to the everyday geographies of coeliacs, arguing that they are 'in particular... very sensitive to and therefore aware of the subtle and often unpublicised ways manufacturers continually alter production processes and the contents of everyday foodstuffs' (Bell and Valentine, 1997, p. 50). Coeliac disease thus provides a way to follow wheat analogous to the role of trace fossils, which preserve not an organism itself but an impression made on a substrate by its activity, for example a footprint or burrow.

We interviewed six people affected by coeliac disease, either because they suffer from it, or because they support another

sufferer as family, friend and/or medical personnel to understand their experiences as consumers who must be constantly vigilant about the presence and absence of wheat. Four of the interview participants were recruited through contact with the NSW Coeliac Society and a further two through contacts with other participants in the larger project.

6. The wheat in food – visible and invisible

The picture of wheat as a healthy staple food is in stark contrast with its categorisation by Food Standards Australia New Zealand (FSANZ, 2009a) as a substance requiring compulsory identification on all food products, and by others (Helfe, 2001) as a 'hidden' ingredient in food. Australian export statistics also allude to the 'hidden' wheat in published categories of grain by level of 'transformation' (Cwth, 2008). Product recall notices on the Food Standards Australia New Zealand website (FSANZ, 2009b) provide an insight into the world of 'hidden' wheat. These notices (Fig. 1a) detail products recalled due to 'incorrect' labelling, according to the

new labelling code, of wheat and wheat derived products. As well as a bread line recalled due to undeclared wheat, other items include various prepared sauces, flavour sachets in processed noodles and confectionery items. Warnings alert consumers to the presence of undeclared wheat and wheat gluten and the potential dangers to the gluten intolerant. Another alert (FSANZ, 2009c), Fig. 1b, provides a list of products which might contain wheat and so should be avoided by those intolerant to it. Significantly, these lists catalogue an enormous variety of everyday staples as well as relatively new food phenomena such as processed meats, seafood extender, and hydrolysed proteins.

The Australian New Zealand Food Standards Code (2009) sets the required standards for the labelling of ingredients, additives and other identification issues relating to food for human consumption for retail sale in Australia, including food sold and/or imported into both countries. According to the code (FSANZ, 2009d) particular substances must always be declared where they are: an ingredient in food; part of a compound ingredient; a food additive or component of a food additive; or a processing aid or component of a processing aid.

The screenshot shows a web browser window displaying a product recall notice. The URL is <http://www.foodstandards.gov.au/foodmatters/foodrecalls/archiveconsumerlevelrecalls/confectionerylabelli4334.cfm>. The page features a search bar and navigation tabs for 'FSANZ HOME', 'STANDARDS DEVELOPMENT', 'THE CODE', 'MONITORING AND SURVEILLANCE', 'FOOD MATTERS', and 'NEWS ROOM'. The recall notice is for a 'Chocolate & Almond Cookie' product, notified to FSANZ on 12 May 2009. The product is described as '120g, Plastic over wrap' and has a 'Best Before' date of '4-Aug-09'. The recall reason is 'Labelling – undeclared allergen (gluten)'. The notice states that Haigh's Manufacturing Pty Ltd is conducting a voluntary recall of the product manufactured by Baylies of Strathalbyn due to undeclared gluten. It also provides contact information for Haigh's Manufacturing Pty Ltd: 153 Greenhill Road, Parkside, 5063, and a phone number 1800 819 757.

Fig. 1a. Product recall notice for undeclared gluten in confectionery product (FSANZ, 2009b).

Address: <http://www.foodstandards.gov.au/foodmatters/foodallergies/wheatallergy.cfm>

FOOD STANDARDS Australia New Zealand
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Quick Links:

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FSANZ Home > Food Matters > Food Allergies >

Wheat

Ingredients to avoid if you are allergic to wheat

- Bran
- Breadcrumbs
- Bulgur
- Couscous
- Cracker meal
- Farina
- Flour
- Gluten
- Kamut
- Matzoh
- Pasta
- Seitan
- Semolina
- Spelt
- Tabouleh
- Triticale
- Wheat+
- Whole wheat berries

Products which might contain wheat include:

- Baked goods (eg bread, cakes, donuts, muffins)
- Biscuits
- Breakfast cereals
- Flavouring (natural/artificial)
- Hydrolysed protein
- Baking mixes/powder
- Battered fried foods
- Canned soups/stocks
- Icing sugar
- Ice cream cones
- Lollies
- Malted milk
- Pancakes
- Processed meats
- Sauces/gravy mixes
- Snack foods
- Soy sauce
- Starch (eg modified, vegetable, gelatinised)
- Surimi
- Vegetable gum/starch

*all-purpose, bread, durum, cake, enriched, high gluten, high protein instant, multigrain, pastry, plain, self-raising, soft wheat, steel ground, stone ground, wholemeal, whole wheat+ bran, germ, flakes, sprouts, cornflour

This is not a complete or comprehensive list of ingredients to avoid but is intended as a helpful aid for living with wheat allergy.

It is NOT meant to replace medical advice given by your doctor.

Fig. 1b. Lists of ingredients and products for wheat intolerant people to avoid identified by Food Standards Australia New Zealand (FSANZ, 2009c).

Wheat must be identified because for sufferers of coeliac disease and gluten intolerance, supermarket shelves are a minefield of wheat which must be negotiated daily to avoid serious health consequences. Coeliac disease is a permanent dietary intolerance to wheat gluten and other similar proteins of rye, barley and oats (Howdle and Losowsky, 1992), resulting in damage to the lining of the small intestine. The condition can manifest as a wide range of symptoms including indigestion pain, autoimmune disease, neurological problems, infertility, osteoporosis and malignant disease (Maki and Collin, 1997; Green and Jabri, 2003). The condition is irreversible and dietary avoidance must be strict and lifelong, although damage to the small intestine can be repaired when gluten is eliminated (Howdle and Losowsky, 1992). Coeliac disease is thought to be relatively common, affecting one in 250 people (Green and Jabri, 2003).

Current guidelines direct that wheat *should* be specifically noted in a food product's ingredient list, including where it may be the source of another ingredient used e.g. starch or sugar (glucose), unless the food is not required to bear a label (the ingredients must then be declared verbally or in writing). Similarly if a food additive such as a colouring or thickener is derived from wheat, that source *must* be declared on the product label. If a label does not disclose that the ingredient was sourced from a listed substance, then 'logically' the food does not contain that substance. The term 'gluten-free' often used on food labels, is problematic for interpreting the presence of wheat in Australian food, as it relates to a no detectable gluten limit rather than a limit of zero gluten (Shepherd and Gib-

son, 2006). A more comprehensive list of examples of wheat and gluten containing and derived products is provided by Shepherd and Gibson (2006, pp. 159–161).

Of the 10,235 items surveyed, 6710 were food (Table 2) and 3525 were non-food (Table 3). These surveyed items include a significant proportion of food (10%) and a majority of the non-food items (66%) not labelled in a way that allowed wheat or wheat based products to be identified. Items without labels, ingredients lists and/or items with partially disclosed ingredients, were identified as no ingredients listed in Tables 2 and 3. The majority of food items without labels were fresh fruit, vegetable and fresh meats, which are sold in bins and not packaged, or alternatively refrigerated with only simple packaging. However, there were also processed foods including rice and tea, many of which contained multiple ingredients, which were unlabelled. Some items were difficult to survey because the labels were folded over and the ingredients obscured. A small number of imported products were not labelled in English (although The Code requires these ingredients to be translated).

According to the labels, 20.7% of all surveyed items (1977 food and 144 non-food) contained wheat. Most of this concentration is in food, with about 29.5% of all surveyed food items containing wheat. Across all food items, wheat was most commonly present in staples including breads, breakfast cereals, and other baked items like muffins and biscuits (Table 2). These are products where the connection to wheat is both visible and celebrated (Fig. 2). Depictions of wheat as a crop or a grain on packages make this

Table 2

Supermarket food items, sorted by the number of items identified as having wheat present.

Category	No. items	No ingredients listed	Number surveyed	Number with wheat present	% Wheat present (of surveyed)
Other breads, muffins, etc	173	0	166	161	97
Everyday biscuits	124	0	117	115	98
Cereals, liquid breakfast	124	0	122	98	80
Pasta	99	0	99	97	98
Lollies	187	2	155	97	63
Frozen meals and pizza	99	0	84	83	99
Canned soup	117	0	102	66	65
Noodles	62	0	62	62	100
Packet soups	118	0	72	62	86
Chips	149	1	116	60	52
Rice and pasta side dishes	61	0	59	58	98
Muesli and fruit bars	87	0	80	58	73
Chocolates	111	1	105	54	51
Cooking and baking needs	136	0	112	52	46
Cake mixes	101	2	99	51	52
Savory crackers and crisp breads	61	0	58	47	81
Marinades	103	0	98	45	46
Baked beans and spaghetti	87	0	80	41	51
Chocolate biscuits	44	0	40	40	100
Chilled meals	64	0	50	40	80
Dinner bases, recipe mixes	72	0	54	39	72
Rice crackers and snacks	49	0	42	34	81
Jams and spreads	147	0	131	30	23
Frozen desserts and pastry	34	2	33	30	91
International foods	150	1	98	29	30
Herbs and spices	289	2	216	28	13
Custard desserts	73	0	66	25	38
Baby food	150	0	114	24	21
Health foods	152	0	100	21	21
Vinegars and dressings	85	2	70	18	26
Gourmet bake house	27	0	17	17	100
Muesli and oats	40	0	30	17	57
Vitamins	254	8	199	17	9
Ice-cream and ice blocks	33	0	26	16	61
Hot chocolates	39	0	37	16	43
Coffee	183	18	146	16	11
Microwave meals	24	0	19	15	79
Canned meals	25	0	21	15	71
Frozen poultry	22	0	17	14	83
Pasta sauce	92	0	84	14	17
Canned fish	199	0	180	14	8
Frozen crumbed fish	24	0	13	13	100
Meat and poultry	110	59	95	13	14
Simmer sauces	43	0	27	12	44
Mustards	89	0	84	11	13
Cones, toppings	33	0	28	10	36
Frozen vegetables	57	0	47	10	21
Chilled desserts and snacks	55	0	52	10	19
Ice-cream and yoghurt tubs	29	0	28	9	32
Nuts and popcorn	34	0	32	8	25
Small goods	65	0	52	7	13
Long life milks	74	11	68	7	10
Bake at home needs	6	0	6	6	100
Fruit and vegetables	254	228	242	5	2
Gourmet sweets	5	0	4	4	100
Delicatessen	39	0	21	4	19
Cheese	148	1	141	3	2
Fruit and nuts	97	6	82	3	4

Table 2 (continued)

Category	No. items	No ingredients listed	Number surveyed	Number with wheat present	% Wheat present (of surveyed)
Energy drinks	64	0	47	2	4
Long life juices	122	0	96	1	1
Canned vegetables	158	0	147	1	1
Chilled milk	47	1	44	1	2
Seafood	16	11	14	1	7
Gluten-free products	55	0	48	0	0
Promotional lines	4	0	0	0	0
Cooking oils	83	81	83	0	0
Gourmet pantry	76	0	0	0	0
Gourmet deli	11	0	0	0	0
Sparkling wine	62	0	62	0	0
White wine	147	0	147	0	0
Red wine	179	0	179	0	0
Wine and ciders	106	0	106	0	0
Beer	82	0	82	0	0
Eggs	23	0	23	0	0
Chilled yoghurt and creams	140	0	118	0	0
Chilled juice	54	0	47	0	0
Dips and pates	32	0	24	0	0
Butter and margarine	68	0	60	0	0
Mineral waters	68	0	59	0	0
Mixers	44	0	34	0	0
Soft drinks	156	0	148	0	0
Gourmet hampers	9	0	0	0	0
Cordials	47	0	46	0	0
Christmas hampers, biscuits	35	0	0	0	0
Canned fruit desserts	120	0	116	0	0
Rice	48	0	48	0	0
Lunch box drinks	62	1	56	0	0
Organic butcher	43	3	32	0	0
Organic fruit and vegetables	46	43	43	0	0
Tea	203	203	203	0	0
Totals	7818	687	6710	1977	
% Of surveyed food items		10%	100%	29.5%	

connection explicit, aiming to connote a natural product. For example, a leading breakfast biscuit presents itself as ‘97% whole grain’, with a stylised head of wheat. The connection between the natural product and the nation is also common; this same cereal is ‘Australia’s Favourite Breakfast Cereal. Made by Aussies. Loved by Aussies’. A leading brand of flour encircles the wheat stalk with the text ‘Made in Australia since 1898’.

Wheat was commonly present in highly processed foods such as sweets, frozen meals, packet soups and chips, and in processed foods which are not necessarily staples including pre-prepared meals, snack bars, chocolates, baking needs, cake mixes, marinades, savoury crackers and crispbreads (Table 2). It was found often, but not consistently, in foods which might not be commonly thought of as containing wheat, including vinegars and dressings, gourmet products, mueslis, vitamins, ice-creams and ice blocks. Constituent wheat compounds (starch, gluten or glucose, etc) form part of the ingredients for these foods, but these compounds may also be sourced elsewhere (i.e. the starch from rice or the glucose from sugar cane). Canned vegetables, cheese, chilled milk and seafood are some of the foods in which wheat would be least expected, but it was present in some of these in highly processed forms such as wheat derived soy sauce or derived caramel colour. None of the more processed foods drew attention to the wheat connection on the packaging, since to do so would be to render the industrial nature of their production visible.

Food items that did not contain wheat included gluten-free speciality ranges; wine and soft drinks; yoghurts, creams and juices;

Table 3
Supermarket non-food items, sorted by the number of items identified as having wheat present.

Category	No. items	No ingredients listed	Number surveyed	Number with wheat present	% Wheat present (of surveyed)
Dog food tinned and dry	177	162	162	68	42
Hair care and hair colour	288	4	244	39	16
Other pet food	46	3	33	20	61
Cat food tinned and dry	163	145	145	6	4
Skin care	178	2	139	5	4
Pain relief personal care	217	57	187	2	1
Cosmetics	58	3	41	1	2
Soaps	117	10	95	1	1
Pet care	62	26	35	1	3
Shaving products	125	46	107	1	1
Disinfectant	19	1	16	0	0
Sun cream and hair removal	45	1	37	0	0
Packaging	2	2	2	0	0
Manchester	5	3	3	0	0
Tableware	9	6	6	0	0
Baby toiletries	79	6	69	0	0
Small appliances	8	7	7	0	0
Motoring	10	7	7	0	0
Haberdashery	10	7	8	0	0
Toys	61	8	8	0	0
Potting mixes	24	12	23	0	0
Stationary, books, cards	235	16	17	0	0
Gardening	19	16	16	0	0
Home maintenance	19	17	17	0	0
Laundry	118	17	109	0	0
Paper towels	18	18	18	0	0
Flowers	20	20	20	0	0
Oral care	161	22	155	0	0
Garbage bags	26	25	25	0	0
Sponges and wipes	26	26	26	0	0
Baby needs	44	37	37	0	0
Magazines	42	41	41	0	0
Tissues	41	41	41	0	0
Deodorants	97	42	89	0	0
Dishwashing	51	45	51	0	0
Serviettes and picnic needs	47	47	47	0	0
Fabric softeners	64	54	63	0	0
Toilet rolls	55	55	55	0	0
Food wraps	66	63	63	0	0
Beauty aids	79	70	76	0	0
Insecticides	78	74	74	0	0
Hosiery	77	77	77	0	0
Toilet cleaners	100	81	84	0	0
Footwear	1	0	0	0	0
Spirits	126	96	125	0	0
Household cleaners	166	105	132	0	0
Feminine hygiene	109	108	108	0	0
Household cleaning	128	110	113	0	0
Kitchen and bake ware	124	111	113	0	0
Socks and under ware	146	144	144	0	0
Electrical and batteries	230	215	215	0	0
Total	4216	2311	3525	144	
% Of surveyed non-food items		66%	100%	4%	

and meat, fruit and vegetables, all supermarket-defined categories, which contained both processed and unprocessed foods.

In one sense coeliacs defy the contemporary wisdom that consumers are alienated from their food. They and their families have

to follow their food very closely and understand exactly what is in it, even if they would rather not. The food labeling code in Australia helps them to do this and they in turn drive the innovation and regulation of the Code. When they start reading the labels, wheat becomes visible. Melinda is not herself a sufferer of coeliac disease but has nine family members diagnosed with the disease. Her family has known about the disease and its symptoms for a long time. As well as commonly missed favorites like sliced white bread, sufferers and others affected also spoke about missing foods which limited their social interactions. Melinda was surprised how much wheat is in food.

You wouldn't think there would be gluten in ice-cream, would you, or tomato sauce? I mean we know soy sauce but all the other things that gluten is in... lollies, I never thought lollies, you know you can't have all these different sweets, you can't have that, that's quite amazing, it does surprise you... 'Melinda'

The initial diagnosis period can be difficult for adults who have already become accustomed to the tastes of particular foods, even if they do make them sick. Food providers are sometimes questioned at length by sufferers to ensure the food is strictly gluten-free, and a number of participants recount difficult experiences where they have trusted the advice given to them, then eaten the supposedly gluten-free food, only to end up very sick later on. Some of the participants spoke about fashionable food trends and diets such as 'gluten-free' which have confused food providers about safe levels of gluten in food.

Pauline has coeliac disease and has family members who are sufferers. As a dietician she also advises coeliacs about how to manage their food. Her experiences are easier than those of her mother, who had to find wheat free foods in the days before the new food code. In the past a coeliac diagnosis was a sentence to only eat fully home prepared food, but the labelling laws have allowed for the incorporation of some semi and highly processed foods. Some of the older participants also describe the availability of gluten-free foods today as a 'veritable smorgasbord'. Pauline teaches her patients how to read labels and identify products free from wheat. For some participants their families have adapted over time to the necessary restriction by becoming thoroughly familiar with food labelling and wheat based ingredients, and knowing the brands which are safe and those which are not. Some participants talked about sharing family recipes and finding substitutes for ingredients as a way of extending their food repertoire. Particular difficulty was associated with eating out, either at restaurants or at friends' houses, and especially while travelling. Pauline described eating at home or eating at trusted friends homes as a strategy to avoid the potential danger of eating out.

...it's a good social thing to do, go out and have a meal with friends, so yeah, I guess that has changed a bit ...they're quite good now so they'll always check with me where I want go for dinner which is really nice, but often we'll have meals at each others' houses now too, that makes it easier as well. Pauline

Fiona also suffers from coeliac disease. She said she has been sick all her life, but was not diagnosed until she was in her mid-fifties. Fiona also had difficulty travelling. In her words "I'd travel anywhere and feel quite sick." Ironically for Fiona, the only place she didn't get sick was at home, a wheat/sheep farm in central NSW she runs with her husband and two grown sons. Fiona served us gluten-free biscuits with our tea in her farm kitchen, commenting how much easier it now is to find gluten-free foods in the supermarket of the regional town where she shops.



Fig. 2. Examples of Australian food packaging celebrating wheat and grain ingredients.

7. The wheat in non-food – much less visible

Wheat is more difficult to find in non-food items at the supermarket. We might not expect non-food items to be labelled with the same stringency as food, but these are also things that we put onto and into our bodies - most notably pharmaceuticals such as pain relief. Many non-food products simply have no ingredients listed. Only 4% of non-food items were identified as containing wheat. Wheat was most commonly identified in pet food, and also in hair care and hair colour products. These products were the most clearly labelled categories of non-food items (Table 3) but even in these product lines, many items had unclear or inconsistent labelling. A smaller number of other products did identify wheat as an ingredient, including skin care, cosmetics, and shaving products, although many of these had only partial disclosure of their ingredients (e.g. 'active ingredients only'). By contrast, vaginal pessaries sold in pharmacies list non-active ingredients and proclaim themselves gluten-free.

In fact wheat is a very significant ingredient in the manufacture of some non-food products at the supermarket. One example which neatly illustrates the invisible wheat is dry pet food. Although a limited number of 'premium' pet food products promote their gluten-free status, and some brands are labelled in detail, most use language which renders the ingredients unclear or unidentified, for example 'contains cereals'.

It may be invisible but as one manager with a fast moving consumer goods company explained, wheat is critically important in

the manufacture of the dry pet food so popular in the Australian market. As well as being the major source of carbohydrate, it is the wheat proteins, the gluten, that allow the finished extruded product to be formed correctly during manufacturing. Manufacturers rely on this textural property to give shape to the processed mixture that forms the kibble. As with the stock feed industry (see below) grain substitution does occur, but in reality this can only be manipulated to a certain extent. In addition to the grain which is processed onsite, tertiary manufactured wheat glens are added to aid this process.

Wheat is still probably our critical item... the gluten properties within wheat. So the actual chemistry of wheat provides a product which allows us to create a kibble product so it extrudes well. So cereals, wheat is critical. We can, as I said on the margins probably substitute to some extent, but... without some sort of significant change in technology, I would still see us consuming wheat decades down the track. It's a very cost effective, natural product that allows us to provide a good quality product. Manager, Fast Moving Consumer Goods Company

In the competitive pet food industry, the shape of the extruded product is central to brand identity. Extrusion technology is a closely guarded industry secret and we were not permitted to tour the factory. Hidden wheat thus increases the capacity of the company to make its product visually distinctive and more marketable. The

importance of wheat as food to the dog is here secondary to its transformative properties in the hands of the human manufacturer.

8. Craftable wheat

The craftable qualities of wheat are further expounded by food scientists Dennis and Kevin, and starch scientist Jeff, whose roles are to create new products such as different types of bread, noodles and starch-based products. These researchers were interviewed in their offices. For them, the wheat ‘shows up in everything’, in Kevin’s words, but it can also be hidden. It is an exciting raw material, and the source of considerable professional pride for each scientist. While they understand wheat as ubiquitous, Dennis also challenges the idea of wheat as a single coherent entity:

...wheat isn’t wheat. Wheat is lots of different types of grains for different purposes. ...for example, the wheat you use for making pasta is completely different from the wheat that you use for making bread and the wheat that you use for making biscuits is completely different again. ... Dennis, Food Scientist

Jeff’s role is to work with one part of the wider wheat entity; to diversify market opportunities for particular wheat gluten proteins. The gluten itself is the first thing to be separated from the 1200 tonnes of flour which arrives daily at his starch plant site. One hundred and forty tonnes of gluten a day is washed, dried and then sold for use in the baking industry, particularly in the manufacture of bread in the United States, where additional protein is required to ‘hold up’ the dough. Gluten is also added to vegetarian foods, to pet foods, to aquaculture and other meat industries as an additional source of protein. According to Jeff, the gluten is one of the most lucrative and versatile products.

A more recent development, which is one that I’ve been heavily involved in, is developing new proteins from gluten...which we now call ‘isolated wheat proteins’. They’re a wheat protein which has been modified so that it can behave as, what we call functional food ingredients, and they’re used in a wide variety of applications depending on how we manufacture them. So now, instead of wheat going into the baking industry as gluten, we now have wheat proteins going into the meat industry where they compete with soy bean proteins. Jeff, Research and Development Manager

The isolated wheat proteins are added to foods such as processed meat for nutritional supplementation, as a replacement for more expensive meat proteins, and as an emulsifier, to bind the fat in manufactured meat products like frankfurters and meat pies, so that the product can be handled more easily. Similarly glutamine is an amino acid naturally occurring in the body, but isolated and sold as a nutritional supplement for patients with a variety of diseases and for sports medicine. As Jeff explains, these wheat proteins have particular market and processing advantages in the way that they can be obscured and hidden.

...in fact now we’re utilising wheat proteins to wholly or partially replace milk proteins in milk, dairy like foods. We’ve been able to develop processes which take out all the cereal flavour. Nobody wants ice-cream that tastes like the cone, so we’ve been able to take the flavour away from the wheat protein and produce a protein material which basically is bland and can be used for almost whatever that protein can be used. ...the expensive sports and health foods you see around now are glutamine enriched. Jeff, Research and Development Manager

‘Nobody wants ice-cream that tastes like the cone’. The ‘naturalness’ of ice-cream is enhanced by the invisibility of the wheat. In contrast, visible wheat enhances the naturalness of bread. For example, one of Dennis’s proudest professional achievements is the creation of a women’s health bread that includes soy and linseed as well as wheat. Its structure and ingredient list is just as complex as ice-cream, but this bread celebrates its connection to wheat with packaging that denotes an individual farmer hand harvesting a golden field of grain.

9. Wheat in food but not as food – energetic wheat

We don’t care... To us wheat is wheat. Wheat is energy for us. That’s what we buy it for. Allan, Stock Feed Mill Manager

Important components in the supermarket are pig meat and milk. In the US it takes an estimated 5.9 kg of grain to produce a kilo of pork and 0.5 kg to produce a litre of milk (Pimentel and Pimentel, 2008). The production and regular supply of meat and milk in Australia is also dependent on grain but instead of corn, wheat is critical. In 2005–2006 Australia actually consumed slightly more of the wheat it used domestically in the production of stock feed than was used directly as human food (ABARE, 2006). As the most significant source of energy for both pigs and dairy cows, wheat becomes part of bodies, first animal and then human.

With its incorporation in higher levels of the food chain, wheat contributes to the construction of human food (meat and milk), but in a way that transforms itself out of existence. Allan is general manager of a stock feed mill in country NSW. His blunt summary above indicates a coherent and singular identity for wheat (rather than interest in its constituent components), but he values it not as wheat but as kilojoules for stock feed.

Allan’s company is a fully integrated producer, controlling the whole of the production process; the ‘‘Birth to Bacon’’ system. They grow and produce the feed, breed, grow and slaughter the pigs, and provide meat to wholesale outlets. In 2006, they made about 320,000 tonnes of feed and supplied all of the feed required for their more than one million pigs, as well as some feed for sale.

In this industry wheat really is at the heart of the matter. Although there is some substitution of grain types in the various stock feed recipes for cost and availability, the sheer quantities of grain required determine that wheat is the most significant grain used. Wheat as both grain and mill offal is the major energy or carbohydrate component in the feed, and pigs need to be fed regardless of mechanical breakdowns or other mishaps. As the piggeries have limited feed storage capacity, the whole feed production process operates 24 h per day, 7 days per week. The feed mill stores about 30,000 tonnes of grain onsite in 9000 tonne bulkheads. They receive the grain from trucks, move it around in elevators and on conveyors. They hammer mill the wheat that they receive as grain and combine it with different ingredients in recipes customised for different uses, hot mashing it in three tonne batches before pelleting it through a press and sieve. Eventually the finished product is trucked out in two hundred truck movements a week.

Although the feed pellets are produced throughout the year, harvest is the most important time for the business. Allan reports that they ‘go mad’, working very hard accumulating grain at this time because this is when it is sourced at its cheapest possible price. This process of accumulation can include physical acquisition, but mostly involves financial transactions to secure shares in the wheat pool. Without accumulation, a constant regular supply of grain to the mill could not take place. The timing of this accumulation makes all the difference to the price.

Price of wheat, price of meat. They are two things that drive this business. It's that simple...The two things, the key things that drive people's decision to buy meat is price and whether they feel it's a wholesome product and I think that's the key to it...whether the actual retailer, the person who ultimately buys that animal has any concept that once they were fed wheat, I think that's long been separated. Allan, Manager, stock feed mill

Similarly Mick, a dairy farmer on the south coast of NSW, is 'purely and simply after an energy source. We can find protein elsewhere.' Mick's family has been farming on their property since 1839 and his son will be the sixth generation to do so. Mick milks 250 cows on 280 hectares and produces over 2 million litres of milk a year. Things have changed a lot for Mick since he began dairying; deregulation of the Australian dairy industry, significant mechanisation and genetic introductions from European, North American and New Zealand stock, resulting in improvements in the Australian dairy herd. Instead of 2500 l per head a year when he first started dairying in the 1960's, Mick's cows now average about 8000 l per year.

As a result of this change Mick has had to employ a number of strategies to remain dairying, including developing direct relationships with grain growers, cutting out the 'middlemen' so that he can receive grain without the additional handling and on-costs. During 2006 Mick purchased about 500 tonne of wheat, which he stores onsite. He owns his own roller mill which he uses to crack the grain to add to purchased pelleted stock feed. Mick also supplements with biscuit meal which is a by-product of biscuit and cereal manufacturing. According to Mick his cows might receive over 50% of their ration in wheat, the rest in grass, hay and silage. Buffers and pro-biotic additives, which stimulate gut bacteria, are required in order for the cows to be fed grain and grain products in these proportions.

It's not hard to work it out...For example a cow giving 30 l of milk a day will require approximately, I've got to do the sums in my head, 26 kg of dry matter per day and we at times feed up to 12 kg of dry matter in the dairy which is the wheat ration. So they could be getting over 50% of their total ration from purchased grain, purchased feed, whether it be in the pellets or in the straight wheat. Mick, Dairy Farmer

The rations do vary, according to season, availability and price. In the winter rations need to be supplemented, because the paddock grass growth slows down and the cows need additional feed as they burn energy keeping warm. Australian dairy herds are generally not housed indoors during winter. Rations also vary because of the way in which Mick is paid for his milk, which is according to the protein and fat content. And so depending on the cow, he uses the nutritionists' services to adjust the diet to the extent possible, to produce the most profitable proportions of protein and fat content in the milk, for a given volume. Finally the feed rations also vary because of grain substitution. Due to seasonality and price factors, wheat is varied and split with other grains. But wheat is still critical.

Barley, triticale, oats. Wheat is the grain with the highest energy value. And in fact given we may get back one day to normal seasons we would probably split the grain 50/50 wheat, 50/50 triticale. And triticale is actually a derivative from wheat anyway. Mick, Dairy Farmer

Wheat energises the system, but rather than being unidirectional, it moves around, re-energising other parts of the network, fuelling and feeding as it goes. As encapsulated energy, it can be stored and pooled, moderating seasonality and the variability of

drought. Its mobility and energetic power allows Mick to stay on his land and farm in the face of considerable economic pressure to do otherwise.

10. Conclusions – wheat as stable and unstable category

Our initial interest in following the wheat into the supermarket was to explore more dynamic aspects of its spatiality, particularly the hidden dimensions of wheat. The visibility of these processes, and thus of the wheat itself, is regulated and marked in both formal and informal ways. An outcome is that wheat has a much more fixed identity as a human food than as non-food products. This identity is fixed in markers that denote both presence and absence, facilitated by regulatory regimes concerned with the health of the human body.

As the healthy staple food of the nation, wheat is marked and celebrated via imagery of grains, stalks, sheafs and golden fields on food packaging. It is presented as a product of nature. Consumers understand themselves to be eating wheat, an unmediated product, often presented with a visual connection to the farmer and the paddock (but never the truck or the factory). Even the highly crafted soy and linseed bread masks its crafting with images on the package that connect it back to nature. The human body is understood as the right place for this food, unless of course the human is a coeliac sufferer.

In the latter case wheat is dangerous and must be kept outside the body. But its identity is just as fixed, in fact more so because of its dangerous qualities. These qualities are what have rendered it visible in new labelling regimes designed to protect consumer health. In the experience of coeliacs wheat is 'surprisingly' everywhere, but also, not really food. Instead it must be located and avoided.

Outside the regime of human food, wheat is a much less stable category. In non-food products within the supermarket it is not even labelled as existing, let alone as wheat. For manufacturers, food and industrial scientists, the malleability and unstable identity of wheat is what they value about it. It is easy to hide. Its capacity to be broken down as different constituent parts, and re-raftered into other things is fundamental. In industrial processes in laboratories and factories, the constituent components of wheat grain are broken apart, regrouped and reconstituted into new collectives; stock feed, functional foods and isolated proteins. Thus the pet food manufacturer celebrates the gluten which allows the kibble to be extruded into shapes with brand identity; the stock feed miller and the dairy farmer value wheat as energy; the starch scientist separates wheat proteins that enhance the mouth feel and texture of meat pies and ice-cream. These food crafters further challenge the analytical distinction between consumption and production, being both consumers of the farmer's product, and producers of new goods for consumers in supermarkets and elsewhere.

The ongoing elision of wheat for food as a fixed category, corresponding to 'nature', fuels the expectation that food will and should be cheap. As a product of nature people expect to pay very little for it, and will likely resist internalisation of environmental costs, for example via carbon trading. Nor are they likely to be able to discern, or want to pay the farmer for, a higher quality of generic wheat.

We have sought in this paper to recast the spatiality of Australian wheat in ways attuned to different kinds of mobility, visibility and transformation. Its mobility is at least more complex than usually acknowledged. The flow of wheat is not linear from paddock to port and plate, but occurs in and through complex networks that among other things, creates gluten enriched natural ice-cream. Wheat is more mobile than its non-perishable character would

suggest, with just-in-time processing driving and punctuating its flow. We have shown it to be more ubiquitous than most of us might imagine, many of us unknowingly putting it into or onto our bodies on a daily basis. We present this different way of seeing wheat, not to downplay the importance of understanding broader rural landscapes, rather because they are so important. Discussions about the sustainability of wheat production in the face of climate change, in Australia as elsewhere, will need to consider the diversity and complexity of wheat journeys.

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